Radical®

signal extraction pulse oximeter

OPERATOR'S MANUAL

Masimo SET®

Radical®

Signal Extraction Pulse Oximeter

OPERATOR'S MANUAL

The Radical Operating Instructions provide the necessary information for proper operation of all models of the Radical pulse oximetry system. There may be information provided in this manual that is not relevant for your system.

General knowledge of pulse oximetry and an understanding of the features and functions of the Radical Pulse Oximeter are a prerequisite for its proper use.

Do not operate the Radical Pulse Oximeter without completely reading and understanding the instructions in this manual.

NOTICE
Purchase or possession of this device does not carry any express or implied license to use this device with replacement parts which would, alone or in combination with this device, fall within the scope of one of the patents relating to this device.

CAUTION:
FEDERAL LAW (U.S.) RESTRICTS THIS DEVICE TO SALE BY OR ON THE ORDER OF A PHYSICIAN.

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MEDICAL ELECTRICAL EQUIPMENT WITH RESPECT TO ELECTRIC SHOCK, FIRE AND MECHANICAL HAZARDS ONLY IN ACCORDANCE WITH UL 60601-1/CAN/CSA C22.2 No. 601.1

Covered by one or more of the following U.S. Patents: RE38,492, RE38,476, 6,850,787, 6,826,419, 6,816,741, 6,699,194, 6,684,090, 6,658,276, 6,654,624, 6,650,917, 6,643,530, 6,606,511, 6,584,336, 6,501,975, 6,463,311, 6,430,525, 6,360,114, 6,263,222, 6,236,872, 6,229,856, 6,206,830, 6,157,850, 6,067,462, 6,011,986, 6,002,952, 5,919,134, 5,823,950, 5,769,785, 5,758,644, 5,685,299, 5,632,272, 5,490,505, 5,482,036, international equivalents, or one or more of the patents referenced at www.masimo.com/patents. Products containing Satshare® feature are also covered by U.S. Patent 6,770,028. Other patents pending.

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RadNet, RadicalScreen, Signal IQ, FastSat, FastStart and APOD are trademarks of Masimo Corporation.

SAFETY INFORMATION, WARNINGS, CAUTIONS AND NOTES

The Radical Signal Extraction Pulse Oximeter is designed to minimize the possibility of hazards from errors in the software program by following sound engineering design processes, Risk Analysis and Software Validation.

- Explosion hazard. Do not use the Pulse Oximeter in the presence of flammable anesthetics or other flammable substance in combination with air, oxygen-enriched environments, or nitrous oxide.
- High intensity extreme lights (such as pulsating strobe lights) directed on the sensor, may not allow the Pulse Oximeter to obtain vital sign readings.
- The Pulse Oximeter is NOT intended for use as an apnea monitor.
- A Pulse Oximeter should be considered an early warning device. As a trend towards patient hypoxemia is indicated, blood samples should be analyzed by laboratory instruments to completely understand the patient's condition.
- The Pulse Oximeter is to be operated by qualified personnel only. This manual, accessory directions for use, all precautionary information, and specifications should be read before use.
- Electric shock hazard. Do not open the pulse oximeter cover except to replace the battery of the Handheld unit. Only a qualified operator may perform maintenance procedures specifically described in this manual. Refer servicing to Masimo for repair of this equipment.
- As with all medical equipment, carefully route patient cabling to reduce the possibility of patient entanglement or strangulation.
- Do not place the pulse oximeter or accessories in any position that might cause it to fall on the patient. Do not lift the pulse oximeter by the power cord or any other cable.
- Interfering Substances: SpO_2 is a functional calculation of arterial oxygen saturation. Carboxyhemoglobin and Methemoglobin may erroneously increase SpO_2 readings. The level of increase is approximately equal to the amount of carboxyhemoglobin and/or methemoglobin that is present. Dyes, or any substance containing dyes, that change usual blood pigmentation may cause erroneous readings.
- Severe anemia may cause erroneous SpO_2 readings.
- Do not use the pulse oximeter or oximetry sensors during magnetic resonance imaging (MRI) scanning. Induced current could potentially cause burns. The pulse oximeter may affect the MRI image, and the MRI unit may affect the accuracy of the oximetry measurements.
- If using pulse oximetry during full body irradiation, keep the sensor out of the irradiation field. If the sensor is exposed to the irradiation, the reading might be inaccurate or the unit might read zero for the duration of the active irradiation period.
- For home use, ensure that the pulse oximeter's alarm can be heard from other rooms in the house especially when noisy appliances such as vacuum cleaners, dishwashers, clothes dryers, televisions, or radios are being operating.
- Always remove the sensor from the patient and completely disconnect the patient from the pulse oximeter before bathing the patient.
- Do not place the pulse oximeter where the controls can be changed by the patient.
- Do not place the pulse oximeter face against a surface. This will cause the alarm to be muffled.
- Do not place the pulse oximeter on electrical equipment that may affect the pulse oximeter, preventing it from working properly.
- Do not expose the pulse oximeter to excessive moisture such as direct exposure to rain. Excessive moisture can cause the pulse oximeter to perform inaccurately or fail.

SAFETY INFORMATION, WARNINGS, CAUTIONS AND NOTES (CONTINUED)

- Do not place containers containing liquids on or near the pulse oximeter. Liquids spilled on the pulse oximeter may cause it to perform inaccurately or fail.
- Failure of Operation - If the pulse oximeter fails any part of the setup procedures or leakage tests, remove the pulse oximeter from operation until qualified service personnel have corrected the situation.
- Patient Safety - If a sensor is damaged in any way, discontinue use immediately.
- Disposal of product - Comply with local laws in the disposal of the unit and/or its accessories.
- The Pulse Oximeter Module can be used during defibrillation, but the readings may be inaccurate for up to 20 seconds.
- This equipment has been tested and found to comply with the limits for medical devices to the EN 60601-1-2: 2002, Medical Device Directive 93/42/EEC. These limits are designed to provide reasonable protection against harmful interference in a typical medical installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to other devices in the vicinity. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to other devices, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:
  - Reorient or relocate the receiving device.
  - Increase the separation between the equipment.
  - Connect the equipment into an outlet on a circuit different from that to which the other device(s) are connected.
  - Consult the manufacturer for help.
- A functional tester cannot be utilized to assess the accuracy of the Pulse Oximeter or any sensors.

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About this Manual

This manual explains how to set up and use the Masimo SET Radical Pulse Oximeter, herein known as the Radical. Important safety information relating to general use of the Radical appears before this introduction. Other important safety information is located throughout the manual where appropriate.

Read the entire safety information section before you operate the monitor.

In addition to the safety section, this manual includes the following sections:

SECTION 1 **OVERVIEW** gives a general description of pulse oximetry.

SECTION 2 **SYSTEM DESCRIPTION** describes the Radical system and its functions and features.

SECTION 3 **SETUP** describes how to setup the Radical for use.

SECTION 4 **OPERATION** describes the operation of the Radical Pulse Oximetry system.

SECTION 5 **ALARMS AND MESSAGES** describes the alarm system messages.

SECTION 6 **TROUBLESHOOTING** describes troubleshooting information.

SECTION 7 **SPECIFICATIONS** gives the detailed specifications of the Radical Pulse Oximeter.

SECTION 8 **SENSORS AND PATIENT CABLES** outlines how to use and care for Masimo SET sensors and Masimo SET patient cables.

SECTION 9 **SERVICE AND MAINTENANCE** describes how to maintain, service and obtain repair for the Radical Pulse Oximeter.

SECTION 10 **ACCESSORIES** lists the available Radical accessories.

Warnings, cautions and notes

Please read and follow any warnings, cautions and notes presented throughout this manual. An explanation of these labels are as follows:

A **WARNING** is provided when actions may result in a serious outcome (i.e., injury, serious adverse affect, death) to the patient or user. Look for text in a gray shaded box.

Sample of Warning:

WARNING: THIS IS A SAMPLE OF A WARNING STATEMENT.

A **CAUTION** is given when any special care is to be exercised by the patient or user to avoid injury to the patient, damage to this device or damage to other property.

Sample of Caution:

CAUTION: THIS IS A SAMPLE OF A CAUTION STATEMENT.

A ***NOTE*** is provided when extra general information is applicable.

Sample of Note:

NOTE: *This is a sample of a Note.*

Product description

The Radical Pulse Oximeter is a noninvasive, arterial oxygen saturation and pulse rate monitor. The Radical can be used as either a Handheld or a Standalone monitor. The Radical features a backlit Liquid Crystal Display (LCD) that continuously displays numeric values for SpO_2, pulse rate, plethysmographic waveform and Signal Identification and Quality Indicator (Signal IQ™). The Radical can be used to interface with a multiparameter patient monitor to provide Masimo SET pulse oximetry information to that monitor for display.

FEATURES AND BENEFITS

- Clinically proven as the highest sensitivity and specificity pulse oximeter in the world
- Signal IQ ® waveform for signal identification and quality indication during excessive motion and low signal to noise situation
- FastSat ® tracks rapid changes in arterial O_2 with high fidelity unlike any other pulse oximeter
- FastStart™ allows for rapid measurement from the time the instrument is first turned on
- APOD™ (Adaptive Probe Off Detection) offers the best probe off detection of Masimo's three sensitivity modes - APOD, Normal and MAX sensitivity
- ClearVue™ technology delivers the highest resolution display available
- SmartTone™ beeps in sync with pulse, and with tonal changes for every 1% drop in saturation, even under most patient motion conditions
- SatShare ® interface connection to existing multiparameter monitor *(models RDS-1/1B only)*
- RS-232, analog output, and nurse call interfaces *(models RDS-1/1B and RDS-3 only)*
- User configurability maximizes operation for all applications
- Facilitates economical sensor standardization throughout the hospital
- SpO_2, pulse rate, alarm, trending, perfusion index, Signal IQ and plethysmographic waveform display
- Automatic screen rotation provides upright display for vertical or horizontal monitor positioning *(not available on the RDS-2 model)*
- Remote alarming interface
- Designed for hospital, transport and home use
- Up to thirty days of trending

INDICATIONS FOR USE

The Radical and accessories are indicated for the continuous, noninvasive monitoring of functional oxygen saturation of arterial hemoglobin (SpO_2) and pulse rate (measured by an SpO_2 sensor). The Radical and accessories are indicated for use with adult, pediatric and neonatal patients during both motion and no motion conditions, and for patients who are well or poorly perfused in hospitals, hospital-type facilities, mobile and home environments. In addition, the is indicated to provide continuous noninvasive monitoring data to validated multiparameter patient monitors* for display on those monitors.

*Contact Masimo for the latest list of SatShare validated multiparameter monitors.

Pulse oximetry

GENERAL DESCRIPTION

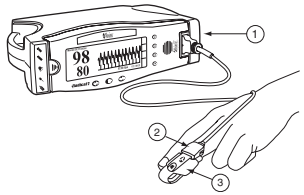
Pulse oximetry is a continuous and non-invasive method of measuring the level of arterial oxygen saturation in blood. The measurement is taken by placing a sensor on a patient, usually on the fingertip for adults, and the hand or foot for neonates. The sensor is connected to the pulse oximetry instrument with a patient cable. The sensor collects signal data from the patient and sends it to the instrument. The instrument displays the calculated data in three ways:

1. As a percent value for arterial oxygen saturation (SpO_2)

2. As a pulse rate (PR)

3. As a plethysmographic waveform

The following figure shows the general monitoring setup.



1. Instrument
2. Patient Cable
3. Sensor

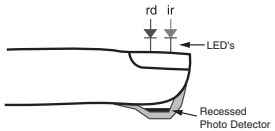
PRINCIPLE OF OPERATION

Pulse oximetry is governed by the following principles:

1. Oxyhemoglobin (oxygenated blood) and deoxyhemoglobin (non-oxygenated blood) differ in their absorption of red and infrared light (spectrophotometry).

2. The amount of arterial blood in tissue changes with your pulse (photoplethysography). Therefore, the amount of light absorbed by the varying quantities of arterial blood changes as well.

The Radical Pulse Oximeter uses a two-wavelength pulsatile system to distinguishbetween oxygenated and deoxygenated blood. Signal data is obtained by passing red(rd)(660 nm wavelength) and infrared (ir)(905 nm wavelength) light through a vascular bed (for example a fingertip, a hand, a foot) and measuring changes in light absorption during the pulsatile cycle. This information may be useful to clinicians. The radiant power of the light is rated at 0.79mW (max.). See figure below. The Radical utilizes a sensor with red and infrared light-emitting diodes (LEDs) that pass light through the site to a photodiode (photodetector). The photodetector receives the light, converts it into an electronic signal and sends it to the Radical for calculation.



Once the Radical receives the signal from the sensor, it utilizes Masimo SET signal extraction technology for calculation of the patient's functional oxygen saturation and pulse rate.

FUNCTIONAL SATURATION

The Radical is calibrated to measure and display functional saturation (SpO_2): the amount of oxyhemoglobin expressed as a percentage of the hemoglobin that is available to transport oxygen.

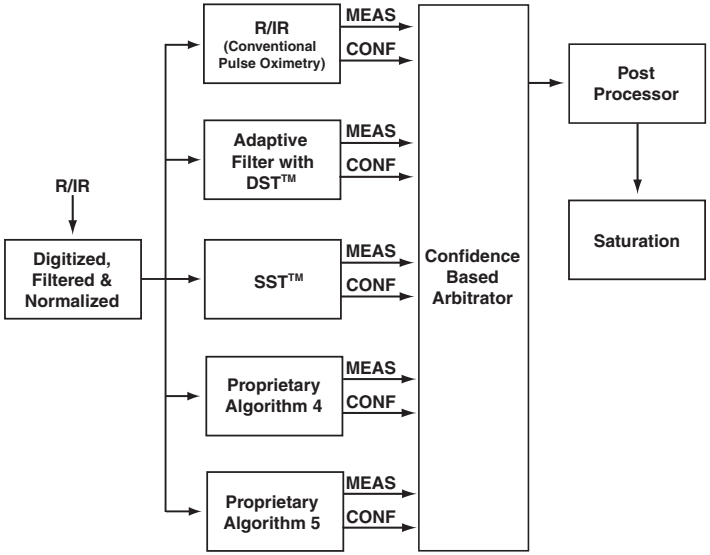
MEASURED VS. CALCULATED SATURATION

Oxygen measurements that can be obtained from the Radical are commonly compared to invasive measurements obtained from blood gas samples. When comparing invasive and noninvasive measurements and interpreting values, caution should be used, as the calculated values obtained from the blood gas sample may differ from the SpO_2 measurements of the pulse oximeter. Different results are usually obtained from the arterial blood gas sample if the calculated measurement is not appropriately corrected for the effects of variables that shift the relationship between the partial pressure of oxygen (PO2) and saturation, such as: pH, temperature, the partial pressure of carbon dioxide (PCO2), 2,3-DPG, and fetal hemoglobin. As blood gas samples are usually taken over a period of 20 seconds (the time it takes to draw the blood) a meaningful comparison can only be achieved if the core oxygen saturation of the patient is stable and not changing over the period of time that the blood gas sample is taken.

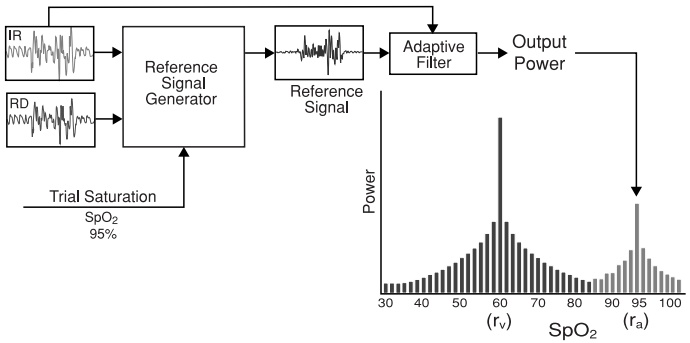
MASIMO SET SIGNAL EXTRACTION TECHNOLOGY

Masimo Signal Extraction Technology's signal processing differs from conventional pulse oximeters. Conventional pulse oximeters assume that arterial blood is the only blood moving (pulsating) in the measurement site. During patient motion, however, the non-arterial blood also moves, which causes conventional pulse oximeters to read low values, because they cannot distinguish between the arterial and venous blood movement (sometimes referred to as noise). Masimo SET pulse oximetry utilizes parallel engines and adaptive digital filtering. Adaptive filters are powerful because they are able to adapt to the varying physiologic signals and/or noise and separate them by looking at the whole signal and breaking it down to its fundamental components. The Masimo SET signal processing algorithm, Discrete Saturation Transform® (DST)®, reliably identifies the noise, isolates it and, using adaptive filters, cancels it. It then reports the true arterial oxygen saturation for display on the monitor.

Masimo SET Parallel Engines



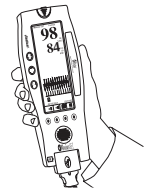
Masimo SET DST



Introduction

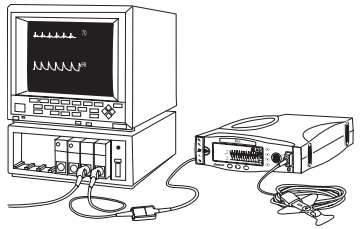
Radical provides the functionality of three pulse oximeters in one:

- The Radical is a fully featured Handheld pulse oximeter
- The Radical is a fully featured standalone pulse oximeter
- The Radical interfaces to the SpO_2 input module of multiparameter patient monitors* to upgrade conventional pulse oximetry technology to Masimo SET technology.



The Handheld portion of the Radical contains the majority of the pulse oximeter features. All pulse oximetry measurement information, as well as device status data is displayed on the Handheld LCD screen. All user input is handled through the control buttons on the front panel. The sensor cable connector is located on the Radical Handheld oximeter.

The Handheld oximeter snaps into the Radical Docking Station to provide a fully featured standalone pulse oximeter. The Docking Station connects to AC power for standalone operation or charging of the Handheld. An optional Docking Station battery is available. The standalone Radical features nurse call, analog output and interfaces to serial printers.



Utilizing a SatShare™ cable, the standalone Radical also interfaces with the SpO_2 input of a validated multiparameter patient monitor*, instantly upgrading the conventional pulse oximetry to Masimo SET pulse oximetry. The SatShare cable attaches to the back of the Radical Docking Station, and SatShare cables are available to interface with most multiparameter patient monitors*.

CAUTIONS:

- THE WAVEFORM DISPLAYED ON THE MULTIPARAMETER PATIENT MONITOR IS A SIMULATED SIGNAL (NON-NORMALIZED). REFER TO THE RADICAL DISPLAY FOR PATIENT WAVEFORM.
- IF DISPLAYING THE SIMULATED WAVEFORM IS NOT DESIRABLE, IT IS RECOMMENDED TO TURN OFF THE PLETH WAVEFORM DISPLAY ON THE MULTIPARAMETER MONITOR
- ONLY USE A SATSHARE CABLE THAT HAS A FERRITE BEAD INSTALLED.

Refer to Section 3, *SatShare Setup* and Section 4, *SatShare Operation* for additional details.

*Contact Masimo for the latest list of SatShare validated multiparameter monitors.

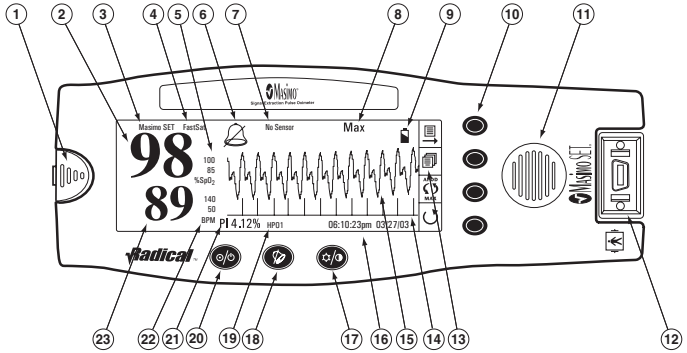
Radical handheld

The Handheld Radical provides most of the functionality of the pulse oximeter. All user input and displays are controlled by this part of the Radical system. The sensor cable connects into the swivel connector on the Handheld unit. The Handheld is battery powered and can be used either as a transport monitor or as a Handheld Pulse Oximeter for spot checks.

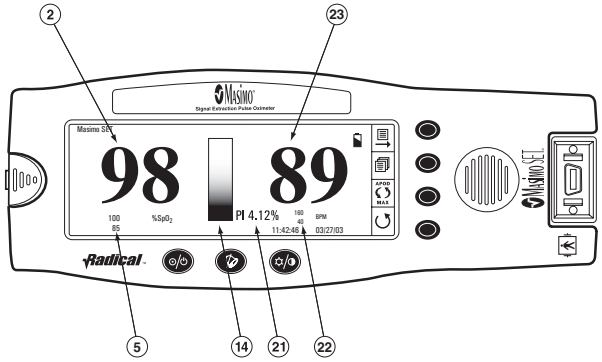
HANDHELD FRONT PANEL

The following figure and corresponding text outline all the features of the Handheld Radical:

Pleth + Signal IQ View



Numbers View

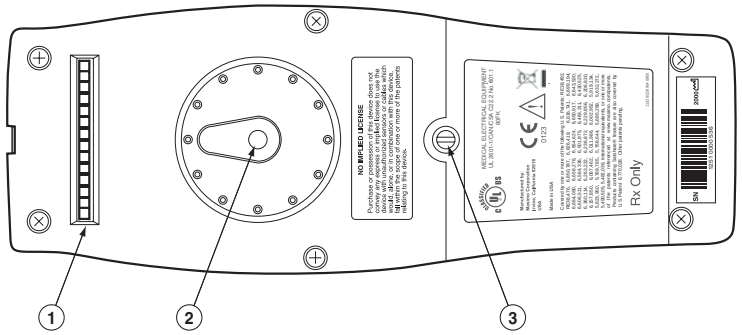


①		**HANDHELD RELEASE BUTTON**	Press down the Handheld Release Button and pull the Handheld device off the Docking Station.
②	98	**SpO_2 MEASUREMENT DISPLAY**	The functional arterial hemoglobin oxygen saturation is displayed in units of percentage SpO_2. The upper and lower SpO_2 alarm limits are also displayed next to the SpO_2 measurement. When a sensor is not connected to a patient and during pulse search, the display will show dashed lines. When the measured value is outside of the alarm limits, the SpO_2 Measurement Display flashes and an alarm will sound. The oxygen saturation is calculated and the display is updated at a frequency of once per second.
③	Masimo SET	**MASIMO SET**	The Masimo SET symbol is shown on the Radical display when SET processing is active. ***Note:*** *Patient information, not Masimo SET, will be displayed when using a RadNet compatible unit connected to a RadNet central station.*
④	FastSat	**FASTSAT**	The FastSat symbol is shown on the Radical display whenever the Radical is set to operate in the FastSat mode.
⑤	100 85	**SATURATION ALARM LIMITS DISPLAY**	The Saturation Alarm Limits Display shows the upper and lower saturation alarm limits. When an alarm limit is reached or exceeded, the SpO_2 value and the violated limit flashes.
⑥		**ALARM STATUS INDICATOR**	The alarm status indicator (a bell) can be shown with or without a slash. It flashes when an alarm condition is present. When the alarm is silenced using the Alarm Silence Button, an alarm status indicator with a slash and a timer is shown to indicate that the alarm is temporarily silenced. When the alarm is silenced through All Mute menu selection, which is permanent until power is cycled or deselected using menu, an alarm status indicator with a slash is shown to indicate that alarm has been silenced.
⑦	No Sensor	**SYSTEM MESSAGE AREA**	The system messages generated by the instrument are displayed in the System Message Area. See Section 5, *System messages*.
⑧	Max APOD	**SENSITIVITY**	The Max or APOD sensitivity icon is shown on the Radical display to indicate if the Radical is set to operate in Normal sensitivity, Maximum sensitivity or Adaptive Probe Off Detection mode. When in Normal mode, this area will appear blank.
⑨		**BATTERY STATUS INDICATORS**	The Battery Status Indicators show the capacity of the Radical Handheld and optional Docking Station batteries. The indicator flashes when less than 15 minutes of battery life is left and the battery needs to be recharged. The Docking Station Battery Status indicator is not shown when the optional Docking Station battery is not present.
⑩		**TOUCH KEY CONTROL BUTTONS**	Press a Touch Key Control Button to select the corresponding touch key icon. See Section 4, *Touch Key Control Buttons and Icons* for more details.
⑪		**SPEAKER**	The speaker indicates audio alarms. Care should be taken not to cover the speaker and muffle the audible alarm volume.
⑫		**PATIENT CABLE CONNECTOR**	Connect the patient cable to the Handheld Radical by plugging the cable into the Patient Cable Connector. Use only Masimo compatible sensors and cables with this oximeter. See Section 8, Sensors and Patient Cables for more details.
⑬	APOD MAX	**TOUCH KEY ICONS**	The Touch Key Icons indicate the software menu items that can be selected through the Touch Key Control Buttons. Pressing a Touch Key Control Button next to an icon selects the option.

⑭	**SIGNAL IQ**	The Signal IQ shows the acquired signal quality and the timing of the pulse. A tall vertical line indicates a high quality signal, while a small vertical line indicates a low quality signal. The Signal IQ may also be shown as a single, pulsating bar.
⑮	**PULSE WAVEFORM DISPLAY**	The Pulse Waveform Display shows the acquired plethysmograph waveform. The pleth waveform is scaled with signal strength. Signal strength is defined as the relation of arterial pulsatile signal to the non-pulsatile signal component.
⑯ 23pm 03/27/01	**TIME AND DATE INDICATOR**	The Time and Date Indicator displays the current time and date. The time is displayed in 12 or 24 hour format. The date is displayed in dd/mm/yy or mm/dd/yy format. Select the date and time display formats in the Clock menu.
⑰	**BACKLIGHT/ CONTRAST BUTTON**	Press the Backlight Button to change the illumination level of the backlight. With the AC line power connected, four levels of illumination are available (in addition to the no illumination level). In the Handheld mode, three levels of illumination are available (again in addition to the no illumination level). Use the lowest illumination for most efficient battery usage. The backlight Button is also used to change the contrast of the LCD display. Press and hold the Backlight Button for longer than six seconds to change the contrast. Release the Backlight Button at the desired contrast setting.
⑱	**ALARM SILENCE BUTTON**	Press the Alarm Silence Button to temporarily silence patient and low battery alarms. Press the Alarm Silence Button when the SENSOR OFF or NO SENSOR messages are flashing (i.e. the sensor is removed from the patient) to acknowledge the end of monitoring. In these states, all further alarms are suspended until the pulse oximeter starts measuring SpO_2 and pulse rate again. ***Note:*** *System failure alarms can be silenced by pressing the Power/Standby or Alarm Silence Button. If the Power/Standby Button does not silence the system fault alarm, press the Alarm Silence Button.*
⑲ HP01 Philips Vuelink	**OUTPUT MODE INDICATOR**	The Output Mode Indicator displays the output mode selected by the user (Philips Vuelink or Spacelabs Flexport). The Output Mode Indicator also displays the type of SatShare® cable. The Output Mode Indicator is only displayed when the Radical device actively outputs data other than ASCII text, or interfaces with a monitor through the SatShare cable. The Output Mode Indicator will take place of the Time and Date indicator when utilized.
⑳	**POWER/STAND BY BUTTON**	Press the Power/Standby Button to turn the instrument on. Press, hold the button for more than 2 seconds and then release the button to turn the instrument off.
㉑ **PI**	**PERFUSION INDEX**	The Perfusion Index indicates numerically the percentage of pulsatile signal to non-pulsatile signal (pulse strength)
㉒ 140 50	**PULSE RATE ALARM LIMITS DISPLAY**	The Pulse Rate Alarm Limits Display shows the upper and lower pulse rate alarm limits. When an alarm limit is reached or exceeded, the pulse rate value and the violated limit flashes.
㉓ **89**	**PULSE RATE**	The Pulse Rate Measurement Display shows the patient's pulse rate in beats per minute. The upper and lower pulse rate alarm limits are also displayed next to the pulse rate measurement. The pulse rate is calculated and the display is updated at a frequency of once per second.

HANDHELD BACK PANEL

The Handheld back panel features the interconnection to the Docking Station, an accessory mount for the pole clamp accessory and access to the Handheld battery pack.



①	**DOCKING STATION CONNECTOR**	The Radical Handheld interfaces with the Docking Station through this connector.
②	**POLE CLAMP ACCESSORY HOLDER**	The optional Pole Clamp accessory attaches to this holder. See the Directions for Use of the Pole Clamp accessories for attachment instructions.
③	**BATTERY PACK**	The Radical Handheld is powered by a NiMH battery located in this compartment. For battery care and replacement please see Section 9, *Replacing the Batteries*.

Radical standalone

When the Radical Handheld is placed into the Docking Station, the Radical becomes a full-featured standalone device. The Radical Standalone acts as a battery charger for the Handheld device and has AC power connection capabilities. The Standalone can also interface to serial devices, nurse call or analog output devices, and multiparameter patient monitors through a SatShare cable.

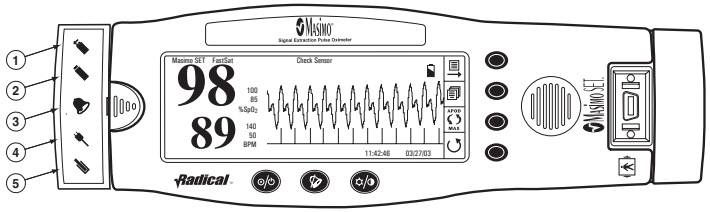
There are several models of Docking Stations available. The following table outline which features are available for each model of Docking Station.

DOCKING STATION FEATURES	RDS-1	RDS-1B	RDS-2	RDS-3	RDS-3B	RDS-4
AC Power Input	■	■	■	■	■	■
SatShare Interface	■	■				■
Serial RS-232 Interface	■	■		■	■	■
Nurse Call/Analog Output Interface	■	■		■	■	
12-hour Extended Battery		■			■	
Automatic Display Rotation Support (Gravity Detector)	■	■		■	■	■
Docking Station Battery Charging Indicator	■	■		■	■	■
Handheld Battery Charging Indicator	■	■	■	■	■	■
Red Alarm Indicator	■	■		■	■	■
AC Power Indicator	■	■	■	■	■	■
Docking Indicator	■	■		■	■	■
Handheld Battery Deep Discharge Support	■	■		■	■	■
Docking Station Battery Deep Discharge Support	■	■		■	■	■

The RDS-1 and RDS-3 are optionally available with RadNet capability. (Refer to Section 3 **RadNet Setup** for details).

STANDALONE FRONT PANEL

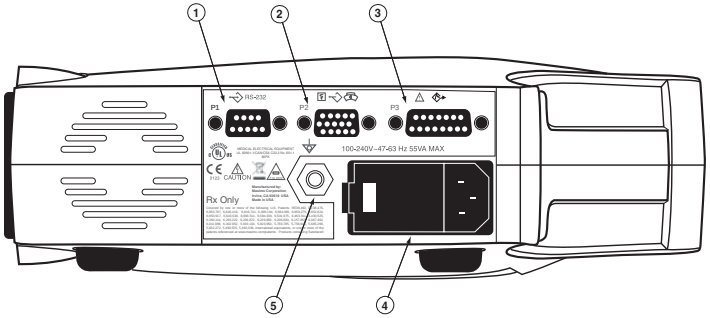
The following figure and corresponding text review the features of the Radical Standalone device.



①		**DOCKING STATION BATTERY CHARGING INDICATOR**	The Docking Station Battery Charging Indicator is illuminated when the Docking Station battery is charging. The indicator blinks just prior to charging. The charging indicator does not illuminate when the battery is fully charged or when the battery is not present.
②		**HANDHELD BATTERY CHARGING INDICATOR**	The Handheld Battery Charging Indicator is illuminated when the Handheld battery is charging. The indicator blinks just prior to charging. The Charging Indicator does not illuminate when the battery is fully charged or when the battery is not present.
③		**VISUAL ALARM INDICATOR**	The Visual Alarm Indicator is illuminated when an alarm condition is active and the Alarm Status Indicator is shown.
④		**AC POWER INDICATOR**	The AC Power Indicator is illuminated when the Radical Docking Station is plugged into AC line power.
⑤		**DOCKING INDICATOR**	The Docking Indicator is illuminated when the Handheld unit is turned on and is properly interfaced to a Docking Station.

NOTE: *When the Radical Standalone is turned on, all indicator LEDs initially turn on and off at start up.*

STANDALONE BACK PANEL



1	**SERIAL OUTPUT CONNECTOR**	Use the Serial Output Connector with a ferrite bead installed to connect a serial device, including a serial printer, RadNet Interface Module or PC, to the Radical. The data is provided in standard RS-232C format. See Section 7, *Serial Interface Specifications*. All external device connections to the Serial Output Connector must be IEC-60950 compliant.
2	**ANALOG OUTPUT / NURSE CALL CONNECTOR**	Use the Analog Output Connector with a ferrite bead installed to interface with an analog output device, such as a chart recorder or nurse call system. All external device connections to the Analog Output / Nurse Call Connector must be IEC-60950 compliant.
3	**SATSHARE CABLE CONNECTOR**	Use the SatShare Cable Connector to connect a SatShare cable to the SpO_2 input connector of a multiparameter patient monitor. All external device connections to the SatShare Cable Connector must be IEC-60601-1 compliant. SatShare cables are available to interface with most major multiparameter patient monitors. Check the label on the SatShare cable and the SatShare Directions for Use to ensure that the correct cable is used for each type of patient monitor. Refer to the Masimo web site at www.masimo.com for the latest SatShare cables and validated instruments.
4	**POWER ENTRY MODULE**	The power entry module contains the input connector for AC power and two fuses. The AC input provides power to the system from the AC line. Always connect the pulse oximeter to the mains power for continuous operation and/or battery recharging. ***NOTE:*** *Use the power cord as the means to disconnect the device from the mains power supply.*
5	**EQUIPOTENTIAL GROUND CONNECTOR**	Use the Equipotential Ground Connector for grounding.

SYMBOLS

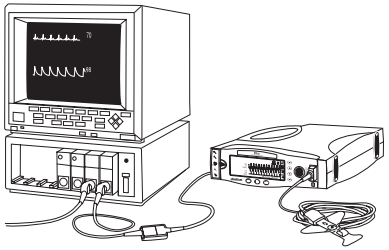
The following symbols are found on the Radical unit, Docking Station or packaging and are defined below:

NOTE: *Some of the interfaces and symbols are not available in all versions of the Docking Station.*

SYMBOLS	DEFINITION
RS-232	RS-232
	SatShare interface
	Equipotential Ground Terminal
	See Instructions for Use
T1A 250V	Fuse Replacement
	Analog Out Interface
	Nurse Call Interface
	WEEE Compliant
CE 0123	Mark of Conformity to European Medical Device Directive 93/42/EEC
Rx ONLY	Federal law restricts this device to sale by or on the order of a physician (USA audiences only)
CLASSIFIED c UL us	Underwriter's Laboratories Inc. approved
5%-95% RH	Storage humidity range: 5% to 95%
+70C -40C	Storage temperature range: +70C to -40C Storage altitude range: +1600hPa to +500hPa
	Keep dry
	Fragile/breakable, handle with care
	Year of Manufacture
IPX1	Protection against liquid drops falling vertically.
	Defibrillation Proof Type BF

Radical monitor interface

In addition to being a full-featured Handheld and Standalone Pulse Oximeter, Radical's unique SatShare interface links the Radical to most existing multiparameter patient monitors through the pulse oximetry patient cable or SpO_2 input connector.



- Upgrades any approved and validated monitor to Masimo SET performance by using the calculated SpO_2 and pulse rate determined by Radical to simulate an ideal waveform, which is sent to the validated multiparameter patient monitor.
- Connects into the SpO_2 patient cable or SpO_2 input connector of the multiparameter patient monitor.

Refer to Section 3, *SatShare Setup* and Section 4, *SatShare Operation* for additional details.

CAUTION: THE WAVEFORM DISPLAYED ON THE MULTIPARAMETER PATIENT MONITOR IS A SIMULATED SIGNAL. REFER TO THE RADICAL DISPLAY FOR THE PATIENT WAVEFORM.

CAUTION: ONLY USE A SATSHARE CABLE THAT HAS A FERRITE BEAD INSTALLED.

Introduction

Before the Radical Pulse Oximeter can be used in a clinical setting, it needs to be inspected, properly setup and the batteries need to be fully charged.

Unpacking and inspection

Remove the instrument from the shipping carton and examine it for signs of shipping damage. Check all materials against the packing list. Save all packing materials, invoice and bill of lading. These may be required to process a claim with the carrier.

If anything is missing or damaged, contact the Technical Service Department. The contact address and phone numbers are listed in Section 9, *Service and Repair*.

Preparation for monitoring

The following sections of the manual describe the preparation, set-up and initial installation of the Radical Pulse Oximeter.

RADICAL POWER REQUIREMENTS

Always use a hospital grade, AC power cable to connect the Radical Pulse Oximeter to an AC power source. Do not connect the Radical Pulse Oximeter Docking Station to an AC outlet controlled by a switch.

Verify the AC power voltage and frequency before use. Verify that the power source can provide adequate power rating as indicated on the rear panel of the Radical Docking Station.

The Radical Pulse Oximeter is designed to operate on 100 to 240VAC, 47-63 Hz. The device is rated at 55 VA max.

Connect a hospital grade power cable to the power entry module of the Radical unit (IEC-320 connector type at the Radical). Connect the power cable to an AC power source. Ensure that the unit is adequately powered by verifying that the AC power indicator on the Docking Station is illuminated.

CAUTION:

- CONNECT THE OXIMETER ONLY TO A HOSPITAL-GRADE RECEPTACLE.
- DO NOT UNDER ANY CIRCUMSTANCES REMOVE THE GROUNDING CONDUCTOR FROM THE POWER PLUG.
- DO NOT USE EXTENSION CORDS OR ADAPTERS OF ANY TYPE. THE POWER CORD AND PLUG MUST BE INTACT AND UNDAMAGED.
- USE THE POWER CORD AS THE MEANS TO DISCONNECT THE DEVICE FROM THE MAINS POWER SUPPLY.

- IF THERE IS ANY DOUBT ABOUT THE INTEGRITY OF THE PROTECTIVE EARTH CONDUCTOR ARRANGEMENT, OPERATE THE OXIMETER ON INTERNAL BATTERY POWER UNTIL THE AC POWER SUPPLY PROTECTIVE CONDUCTOR IS FULLY FUNCTIONAL.
- TO ENSURE PATIENT ELECTRICAL ISOLATION, CONNECT ONLY TO OTHER EQUIPMENT WITH ELECTRICALLY ISOLATED CIRCUITS.
- DO NOT CONNECT TO AN ELECTRICAL OUTLET CONTROLLED BY A WALL SWITCH OR DIMMER.

INITIAL BATTERY CHARGING

Before use, the Radical Handheld battery and the optional Docking Station battery needs to be fully charged.

To charge the batteries, attach the Handheld unit to the Docking Station and plug in the AC power cord. Verify that the batteries are charging. The battery charging LED indicators on the Docking Station flash prior to charging and remain illuminated while the batteries are charging.

Refer to Section 9, *Battery Operation and Maintenance*, for proper battery charging.

INITIAL INSTALLATION

Place the Docking Station on a stable hard flat surface near the patient. Always place the Radical unit on a dry surface. Maintain a minimum of 3 cm (1 inch) free space around the Radical Standalone unit. Make sure that Radical loudspeaker is not covered to avoid a muffled alarm sound.

The Radical Handheld, Docking Station or Standalone should not be operated outside the following environmental conditions:

OPERATING ENVIRONMENTAL CONDITIONS	
TEMPERATURE	+5°C to +40°C, +41°F to +104°F
HUMIDITY	5% to 95%, non-condensing
OPERATING ALTITUDE	1060 mbar to 500 mbar pressure -1000 ft to 18,000 ft (-304 m to 5,486 m)

Monitor setup

The Radical maintains three types of default values which will automatically reverts to after a power cycle:

- Factory – these options are restored to factory values
- Custom – these settings can be changed by the user and retained through the power cycle.
- Adult / Neo – these settings can be selected to revert to factory or hospital-defined values (for Adult or Neonatal) after a power cycle.

The following outlines the default values the Radical reverts to after a power cycle.

FACTORY DEFAULT SETTINGS

OPTION	DEFAULT SETTING
LCD SCREEN ILLUMINATION	
AC Power	Set to maximum, level 4
Battery Power	Set to off
SENSITIVITY	Set to normal mode

CUSTOM (USER) DEFINED SETTINGS

This mode is indicated by "Mode Custom" on the Alarms menu.

The following table outlines the settings that may be changed by the user and the Radical will remember after a power cycle.

OPTION	DEFAULT SETTING
DISPLAY VIEW AND CONTRAST	Set to pre-power down setting
AVERAGING TIME	Set to pre-power down setting
FASTSAT	Set to pre-power down setting
HOME USE	Set to pre-power down setting
INTERFACE ALARMS	Set to pre-power down setting
SATSHARE NUMBERS	Set to pre-power down setting
POWER SAVE	Set to pre-power down setting
DATE AND TIME FORMAT	Set to pre-power down setting
LANGUAGE	Set to pre-power down setting
ANALOG OUTPUT	Set to pre-power down setting
SERIAL OUTPUT PORT MODE	Set to pre-power down setting

OPTION	DEFAULT SETTING
PULSE BEEP VOLUME	Set to pre-power down setting
TREND DISPLAY PARAMETERS	Set to pre-power down setting
TREND PERIOD	Set to pre-power down setting
LOW SpO_2 ALARM LIMIT	Set to pre-power down setting

ADULT/NEO (HOSPITAL DEFINED) SETTINGS

The following table outlines settings that may be defined by the hospital. If enabled (via a password protected screen), these settings will return to pre-defined values after a power cycle. This mode is indicated by “Mode Adult” or “Mode Neo” on the Alarms menu. See Section 4, *Output*, for details on enabling and setting these parameters.

OPTION	CUSTOM SETTING	ADULT / NEO SETTING (PRE DEFINED)
SpO_2 HIGH/LOW ALARM LIMIT	Set to pre-power down setting	Set to pre-defined Adult or Neo setting
PULSE RATE HIGH/LOW ALARM LIMIT	Set to pre-power down setting	
ALARM SILENCE	Set to 120 seconds	
ALARM VOLUME	Set to pre-power down setting	
ALARM DELAY	The 0 and 5 second setting is retained, the 10 second setting is set to 5 seconds	

Satshare setup

The Radical Pulse Oximeter has been proven to be accurate during patient motion and low perfusion conditions. Saturation and pulse rate values from the Radical may be displayed on a multiparameter monitor through the SatShare feature.

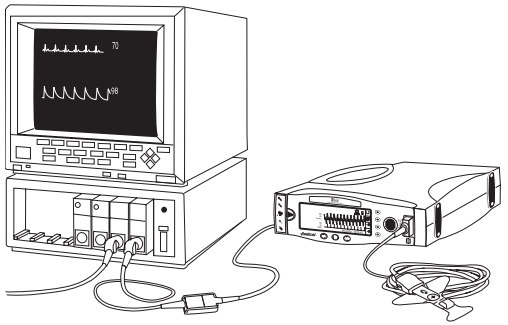
The SatShare feature provides an ideal, simulated waveform corresponding to the measured saturation and pulse rate values determined by the Masimo SET technology. This waveform may be used to display these values on multiparameter monitors through the multiparameter monitor’s oximetry sensor or input connector.

It is recommended that the Radical is positioned close to the multiparameter monitor with the Radical screen visibly displaying the plethysmographic waveform and the saturation and pulse rate measurements.

CAUTION: SIMULTANEOUS USE OF SATSHARE AND SERIAL PORT IS NOT SUPPORTED.

SATSHARE SETUP

1. Select the SatShare cable that is appropriate for the multiparameter monitor that is being connected. Check the Masimo web site at www.masimo.com for the latest list of available SatShare cables and validated instruments.



2. Connect the labeled end of the cable to the SatShare Cable Connector port on the back of the Docking Station. Tighten the connector screws for a secure connection.
3. Connect the other end of the SatShare cable either to the sensor connector of the multiparameter monitor’s SpO_2 cable or directly to the SpO_2 connector on the monitor.
4. Verify that the Radical recognizes the correct cable. The name of the SatShare cable will be displayed on the LCD screen when the SatShare mode is functional.
5. Set the multiparameter monitor’s high and low saturation and pulse rate alarm limits as appropriate.
6. Set the multiparameter monitor's averaging time to the lowest setting (i.e. fastest response). The Radical's ideal waveform obviates the need for additional averaging by the monitor. If the multiparameter monitor's averaging time is not changed, the time to display physiological changes in saturation on the monitor will be increased with SatShare. However, the delay can be minimized by reducing the multiparameter monitor's averaging time.
7. While in the SatShare mode, if there are any significant discrepancies between the readings from the Radical and those on the monitor displaying the values obtained from SatShare, the values reported by the Radical are to be considered the correct values.
8. To use the Radical with SatShare while it is not connected to AC power, set the Power Save parameter in the General menu to "No", refer to Section 4, *Operation*. Please note that if the Radical is used in this mode, the length of time the Radical can operate on battery power will be significantly diminished.
9. Set the SatShare Numbers and the Interface Alarms parameters in the General menu according to Customer preference.
10. If displaying the simulated waveform is not desirable, it is recommended to turn off the pleth waveform display of the multiparameter patient monitor.

CAUTIONS:

- SATSHARE SIGNALS ARE IDEAL SIMULATED WAVEFORMS CORRESPONDING TO THE CALCULATED SATURATION AND PULSE RATE VALUES AND DO NOT CONTAIN ALL OF THE INFORMATION CONTAINED IN PHYSIOLOGICAL WAVEFORMS. THE MULTIPARAMETER PATIENT MONITOR DECODES THESE SIGNALS INTO SATURATION AND PULSE RATE VALUES.
- DURING SATSHARE OPERATION, THE AUDIBLE ALARMS MAY BE MUTED ON RADICAL. WHEN THE AUDIBLE ALARM IS MUTED (INDICATED BY THE BELL WITH A SLASH THROUGH IT) ON RADICAL, USE THE MULTIPARAMETER MONITOR FOR AUDIBLE ALARM INDICATION.
- DURING SATSHARE OPERATION DO NOT USE THE PLETH WAVEFORM DISPLAY ON THE MULTIPARAMETER MONITOR FOR DIAGNOSTIC PURPOSES. INSTEAD, USE THE PLETH WAVEFORM DISPLAYED ON THE RADICAL SCREEN.
- TO AVOID EXCESSIVE BATTERY DISCHARGING, DO NOT CONNECT ANY EQUIPMENT TO THE SATSHARE CONNECTOR UNLESS THE RADICAL PULSE OXIMETER IS CONNECTED TO THE AC MAINS POWER SUPPLY.
- TO ENSURE THAT THE SAFETY LEVEL DURING DEFIBRILLATION IS MAINTAINED, MAKE SURE THAT THE SATSHARE CABLE CONNECTOR IS PROPERLY SECURED AT THE DOCKING STATION.
- ONLY USE A SATSHARE CABLE THAT HAS A FERRITE BEAD INSTALLED.

WARNING: EXTERNAL DEVICE CONNECTIONS TO THE SATSHARE PORT MUST BE IEC-60601-1-1 COMPLIANT.

Philips VueLink setup

CAUTION: SIMULTANEOUS USE OF SATSHARE AND SERIAL PORT IS NOT SUPPORTED.

1. Select the Philips VueLink selection from the Output menu on the Radical. Refer to Section 4, *Output*.
2. Connect one end of the VueLink cable to the Serial Output connector on the back of the Docking Station.
3. Connect the other end of the VueLink cable to the VueLink module and insert the module into the Philips monitor rack.
4. The SpO_2 and pulse rate values will automatically appear on the Philips monitor.
5. In order for the pleth waveform to be displayed on the Philips monitor and for the Philips monitor to indicate the alarm conditions measured by the pulse oximeter, the user must configure the Philips monitor. Please see the Philips Operator's manual for complete instructions.

6. The Radical Pulse Oximeter can be set up to audibly indicate all patient alarms while communicating with the Philips module. Use the Interface Alarms setting in the General menu to enable and disable audible alarms on the Radical.

Spacelabs universal flexport setup

CAUTION: SIMULTANEOUS USE OF SATSHARE AND SERIAL PORT IS NOT SUPPORTED.

1. Select the Spacelabs Flexport selection from the Output menu on the Radical.
2. Connect one end of the Spacelabs Flexport cable to the Serial Output connector on the back of the Docking Station.
3. Connect the other end of the Spacelabs Flexport cable to the Spacelabs Universal Flexport connector.
4. The SpO_2 and pulse rate values will automatically appear on the Spacelabs screen.
5. In order for the pleth waveform to be displayed on the Spacelabs screen and for the Spacelabs monitor to indicate the alarm conditions measured by the pulse oximeter, the user must configure the Spacelabs monitor. Please see the Spacelabs monitor Operator's manual for complete instructions.
6. The Radical can be set up to audibly indicate all patient alarms while communicating with the Spacelabs Flexport module. Use the Interface Alarms setting in the General menu to enable and disable audible alarms on the Radical.

RadNet setup

CAUTION: SIMULTANEOUS USE OF SATSHARE AND SERIAL PORT IS NOT SUPPORTED.

NOTE: Confirm that the Radical Docking Station is RadNet Ready before preceeding.

1. Select the ASCII 2 selection from the Output menu on the Radical.
2. Connect one end of the serial cable to the Serial Output connector on the back of the Docking Station.
3. Connect the other end of the serial cable to the RadNet Interface Module connector.
4. Turn the RadNet Interface Module on.
5. The SpO_2 and pulse rate values will automatically appear on the RadNet Central Station Monitor screen.
6. In order for the pleth waveform to be displayed on the RadNet Central Station Monitor screen and for the RadNet Central Station Monitor monitor to indicate the alarm conditions measured by the pulse oximeter, the user must configure the RadNet Central Station monitor. Please see the RadNet Hardwired and Wireless Systems Operator's Manual for complete instructions.

6. The Radical can be set up to audibly indicate all patient alarms while communicating with the RadNet Interface module. Use the Interface Alarms setting in the General menu to enable and disable audible alarms on the Radical.

CAUTION: REMOVING THE RADICAL HANDHELD FROM THE RADNET READY DOCKING STATION WILL CAUSE LOSS OF COMMUNICATION TO THE RADNET CENTRAL MONITORING STATION. THEREFORE, WHEN BEING USED WITH THE RADNET INTERFACE MODULE, THE HANDHELD LOCKING FEATURE SHOULD BE UTILIZED.

Introduction

To operate the Radical effectively, the device must be set up properly, and the operator must:

- Know how the pulse oximeter derives its readings (see Section 1, *Pulse Oximetry*).
- Be familiar with its controls, components and operation.
- Understand its status and alarm messages (see Section 5, *Alarm Identification*, *System Messages* and Section 6, *Troubleshooting*).

Basic operation

GENERAL SETUP AND USE

1. Inspect the oximeter case for damage.
2. Connect the patient cable to the Patient cable connector of the Radical. Make sure it is a firm connection and the cable is not twisted, sliced or frayed.
3. Ensure that the power cord is plugged into the Power Entry Module of the oximeter and into the AC power.
4. Select a sensor that is compatible with the oximeter before connecting it to the patient cable. See section 8, *Sensors and Patient Cables*. If using a single patient adhesive or disposable sensor, check that the emitter (red light) and the photodetector are properly aligned. Remove any substances that may interfere with the transmission of light between the sensor's light source and photodetector.
5. Attach the sensor to the patient. Refer to the Directions for Use of the sensor.
6. Connect the sensor to the unit (or patient cable) with the logos lining up; make sure it is a firm connection.
7. Press the Power/Standby button to turn the oximeter on.
8. Make sure the display window is free of alarm and system failure messages (see Section 5, *Alarm Identification*).
9. On the display, verify
   - The high and low alarm limits for SpO_2 and pulse rate.
   - The readings for SpO_2 and pulse rate.

   NOTE: *"—" may appear on the numeric display until the SpO_2 and pulse rate readings have stabilized (approximately 10 seconds).*

10. Verify that the patient alarms are functional by setting the high and low SpO_2 and pulse rate alarm limits beyond the patient readings.
    - An alarm tone sounds.
    - The violated alarm limit and reading flash on the display.
    - The red alarm indicator flashes on the Docking Station (standalone operation).
11. Verify the sensor alarms are functional by removing the sensor from the sensor site.
    - "SENSOR OFF" appears in the message area of the graphic display.
    - The alarm tone sounds.
    - The alarm indicator flashes.
    - Disconnect the sensor from the patient cable or oximeter.
    - Confirm that "NO SENSOR" appears in the message area of the graphic display.
12. Verify alarm silence operation.
    - Create an alarm condition by lowering the SpO_2 or pulse rate high alarm limits beyond the patient readings.
    - Press the Alarm Silence button.
    - The alarm tone ceases for the displayed amount of time.
13. To begin patient monitoring:
    - Adjust the alarm limits.
    - Adjust the alarm volumes.
    - Adjust the pulse beep volume.
14. Verify the sensor is on correctly and that the measured data is appropriate, see Section 4, *Successful SpO_2 Monitoring*.
15. Monitor the patient.
16. After monitoring is complete, remove the sensor from the patient and store or dispose of the sensor according to governing rules. See the Directions for Use of the sensor.
17. Press and hold the Power/Standby Button for 2 seconds to turn the oximeter off.

Successful SpO_2 monitoring

The following general points will aid in ensuring oximetry monitoring success.

- Place the sensor on a site that has sufficient perfusion and provides proper alignment of the LED's and photodetector.
- Place the sensor on a site that has unrestricted blood flow.
- Do not constrict the monitoring site when securing a sensor with tape.
- Do not select a site near potential electrical interference (electrosurgical unit, for example).
- Read the sensor Directions for Use for proper sensor application.

MASIMO SENSORS

Before use, carefully read the pertinent sensor Directions for Use.

Use only Masimo oximetry sensors for SpO_2 measurements.

Tissue damage can be caused by incorrect application or use of a sensor, for example by wrapping the sensor too tightly. Inspect the sensor site as directed in the sensor Directions for Use to ensure skin integrity and correct positioning and adhesion of the sensor.

CAUTIONS:

- DO NOT USE DAMAGED SENSORS. DO NOT USE A SENSOR WITH EXPOSED OPTICAL OR ELECTRICAL COMPONENTS. DO NOT IMMERSE THE SENSOR IN WATER, SOLVENTS, OR CLEANING SOLUTIONS (THE SENSORS AND CONNECTORS ARE NOT WATERPROOF). DO NOT STERILIZE BY IRRADIATION, STEAM, AUTOCLAVE OR ETHYLENE OXIDE. SEE THE CLEANING INSTRUCTIONS IN THE DIRECTIONS FOR USE FOR REUSABLE MASIMO SENSORS.
- DO NOT USE DAMAGED PATIENT CABLES. DO NOT IMMERSE THE PATIENT CABLES IN WATER, SOLVENTS, OR CLEANING SOLUTIONS (THE PATIENT CABLE CONNECTORS ARE NOT WATERPROOF). DO NOT STERILIZE BY IRRADIATION, STEAM, AUTOCLAVE OR ETHYLENE OXIDE.
- DO NOT ATTEMPT TO REPROCESS, RECONDITION OR RECYCLE MASIMO SENSORS OR PATIENT CABLES AS THESE PROCESSES MAY DAMAGE THE ELECTRICAL COMPONENTS, POTENTIALLY LEADING TO PATIENT HARM.

NUMERIC DISPLAY - SpO_2

Stability of the SpO_2 readings may be a good indicator of signal validity. Although stability is a relative term, experience will provide a good feeling for changes that are artifactual or physiological and the speed, timing, and behavior of each. The stability of the readings over time is affected by the averaging mode being used. The longer the averaging time, the more stable the readings tend to become. This is due to a dampened response as the signal is averaged over a longer period of time than during shorter averaging times. However, longer averaging times delay the response of the oximeter and reduce the measured variations of SpO_2 and PR.

NUMERIC DISPLAY - PULSE RATE

The Pulse Rate displayed on the Radical may differ slightly from the heart rate displayed on ECG monitors due to differences in averaging times. There may also be a discrepancy between cardiac electrical activity and peripheral arterial pulsation. Significant differences may indicate a problem with the signal quality due to physiological changes in the patient or one of the instruments or application of the sensor or patient cable. The pulsations from intra-aortic balloon support can be additive to the pulse rate displayed on the pulse oximeter.

SIGNAL IQ

The Radical display provides a visual indicator of the plethysmogram signal quality and an alert when the displayed SpO_2 values are not based on adequate signal quality. The signal quality indicator displayed on the Radical is called the Signal IQ. The Signal IQ can be used to identify the occurrence of a patient's pulse and the associated signal quality of the measurement.

With motion, the plethysmographic waveform is often distorted and may be obscured by artifact. The Signal IQ, shown as a vertical line, coincides with the peak of an arterial pulsation. Even with a plethysmographic waveform obscured by artifact, the Radical locates the arterial pulsation. The pulse tone (when enabled) coincides with the vertical line of the Signal IQ.

The height of the vertical line of the Signal IQ indicates the quality of the measured signal. A high vertical bar indicates that the SpO_2 measurement is based on a good quality signal. A small vertical bar indicates that the SpO_2 measurement is based on data with low signal quality. When the signal quality is very low the accuracy of the SpO_2 measurement may be compromised, and a “Low Signal IQ” message is displayed in the message area on the Radical display. When the "Low Signal IQ" message appears proceed with caution and do the following:

- Assess the patient.
- Check the sensor and ensure proper sensor application. The sensor must be well secured to the site for the Radical to maintain accurate readings. Also, misalignment of the sensor's emitter and detector can result in smaller signals.
- Determine if an extreme change in the patient's physiology and blood flow at the monitoring site occurred, (e.g. an inflated blood pressure cuff, a squeezing motion, sampling of an arterial blood specimen from the hand containing the pulse oximetry sensor, severe hypotension, peripheral vasoconstriction in response to hypothermia, medications, or a spell of Raynaud's syndrome.)
- With neonates or infants, check that the peripheral blood flow to the sensor site is not interrupted. Interruption, for example, may occur while lifting or crossing their legs, during a diaper change.

After performing the above, if the "Low Signal IQ" message is displayed frequently or continuously obtaining an arterial blood specimen for CO-Oximetry analysis may be considered to verify the oxygen saturation value.

LOW PERFUSION

The Radical displays a "Low Perfusion" message when there are very low amplitude arterial pulsations.

It has been suggested that at extremely low perfusion levels, pulse oximeters can measure peripheral saturation, which may differ from central arterial saturation[1]. This "localized hypoxemia" may result from the metabolic demands of other tissues extracting oxygen proximal to the monitoring site under conditions of sustained peripheral hypoperfusion. (This may occur even with a pulse rate that correlates with the ECG heart rate.)

CAUTION: IF THE LOW PERFUSION MESSAGE IS FREQUENTLY DISPLAYED, FIND A BETTER-PERFUSED MONITORING SITE. IN THE INTERIM, ASSESS THE PATIENT AND, IF INDICATED, VERIFY OXYGENATION STATUS THROUGH OTHER MEANS.

[1] Severinghaus JW, Spellman MJ. Pulse Oximeter Failure Thresholds in Hypotension and Vasoconstriction. *Anesthesiology* 1990; 73:532-537

ACTIONS TO BE TAKEN

If the SpO_2 readings show significant differences, do the following:

- Make sure the emitter and photodetector are aligned directly opposite each other.
- Select a site where the distance between the emitter and photodetector is minimized.
- Wipe the sensor site with a 70% isopropyl alcohol pad or rubefacient cream (10-30% methyl salicylate and 2-10% menthol) for 20-30 seconds. Strong vasodilator creams, such as nitroglycerin paste, are not recommended.
- If possible, remove electrical noise sources such as electrosurgical units or other electrical/electronic equipment. If these solutions are not possible, operate the oximeter on battery power, or try plugging the oximeter into a different electrical outlet.
- If artificial nails or excessive fingernail polish are present, select another site or remove the polish/artificial nails.
- If possible, ensure that the sensor is placed in a location with low ambient light. Although the Radical with integrated Masimo SET technology has significant immunity to ambient light, excessive ambient light may cause readings to be incorrect.

CAUTION: IF ANY MEASUREMENT SEEMS QUESTIONABLE, FIRST CHECK THE PATIENT'S VITAL SIGNS BY ALTERNATE MEANS AND THEN CHECK THE PULSE OXIMETER FOR PROPER FUNCTIONING.

SENSITIVITY

The Radical is equipped with 3 different sensitivity modes. Each mode allows the clinician to change the sensitivity settings of the device to meet the increased demands of the patient's physiological condition or enable it to work during periods of low perfusion and/or motion. They are as follows:

- **Normal Sensitivity** – This is the recommended mode for patients that are experiencing some compromise in blood flow or perfusion. It is advisable for care areas where patients are observed frequently, such as ICU's.
- **Adaptive Probe Off Detection (APOD)** – This is the recommended start-up monitoring mode for most patients with acceptable perfusion or where a more robust sensor off detection is desired. It is the suggested mode for care areas where patients are not visually monitored continuously. This mode delivers enhanced protection against erroneous pulse rate and arterial oxygen saturation readings when a sensor becomes inadvertently detached from a patient.
- **Maximum Sensitivity (MAX)** - This mode is recommended for patients with low perfusion or when the low perfusion or low signal quality message is displayed on the screen in APOD or normal sensitivity mode. This mode is not recommended for care areas where patients are not monitored visually, such as general wards. It is designed to interpret and display data at the measuring site when the signal may be weak due to decreased perfusion. When a sensor becomes detached from a patient, it will have compromised protection against erroneous pulse rate and arterial saturation readings.

CAUTION: WHEN USING THE MAXIMUM SENSITIVITY SETTING, THE PERFORMANCE OF THE SENSOR OFF DETECTION MAY BE COMPROMISED. IF THE UNIT IS IN THIS SETTING AND THE SENSOR BECOMES DISLODGED FROM THE PATIENT, THE POTENTIAL FOR FALSE READINGS MAY OCCUR DUE TO ENVIRONMENTAL 'NOISE' SUCH AS LIGHT, VIBRATION AND EXCESSIVE AIR MOVEMENT.

Touch key control button and icons

The touch key control buttons are the four dark grey control buttons to the right of the Handheld display. To select a touch key icon, press and release the dark gray control button to the right of the icon.

On the Radical display, four icons are shown on the right side or bottom of the LCD display.

Traditional user interface

FIRST PAGE

NEXT MENU PAGE	Press the Next Menu Page button to access the second page of selections. Press and hold for 6 seconds to toggle between Traditional User Interface and the Simplified User Interface. Enter password when prompted. The Radical will retain this setting after a power cycle.
MENU ACCESS	Press the Menu Access button to enter the main menu.
SENSITIVITY	Press the Sensitivity button to toggle between the Normal, APOD and Maximum Sensitivity modes. Use the Normal Sensitivity setting for typical monitoring purposes. Use the APOD setting where there is a high probability of the sensor becoming detached. Use the Maximum Sensitivity setting for patients with low perfusion or when the low perfusion message is displayed on the screen in APOD or normal sensitivity mode. The default is APOD. ***Note:*** When using the Maximum Sensitivity setting, the SENSOR OFF detection performance may be compromised ***Note:*** In "Custom" mode (see Section 4, Operation) the unit will remain in Normal or APOD setting after a power cycle. Maximum Sensitivity will automatically reset to Normal Sensitivity after a power cycle. In "Neo" or "Adult" mode (see Section 4, Operation) the unit will reset the sensitivity to the hospital specified setting (Normal or APOD) after a power cycle.
ROTATE	Press the Rotate Display button to reconfigure the display screen in a vertical or horizontal format. The display rotates counter-clockwise in 90 degree increments.

SECOND PAGE

NEXT MENU PAGE	Press the Next Menu Page button to access the second page of selections. Press and hold for 6 seconds to toggle between Traditional User Interface and the Simplified User Interface. Enter password when prompted. The Radical will retain this setting after a power cycle.
TREND DISPLAY	Press the Trend Display button to show the trend data on the display.
INCREASE LOUDNESS	Press the Increase Loudness button to increase the volume of the pulse beep. Seven levels of volume exist.
DECREASE LOUDNESS	Press the Decrease Loudness button to decrease the volume of the pulse beep. The lowest volume level will silence the pulse beep.

Simplified user interface

By enabling the Simplified User Interface, users are exposed to only the most common oximeter features, while the all the remaining settings remain available behind password protection.

FIRST PAGE

NEXT MENU PAGE	Press the Next Menu Page button to access the second page of selections. Press and hold for 6 seconds to toggle between Traditional User Interface and the Simplified User Interface. Enter password when prompted. The Radical will retain this setting after a power cycle.
ALARM MENU	Press the Alarm Menu Access button to enter the alarm settings menu.
SENSITIVITY	Press the Sensitivity button to toggle between the Normal, APOD and Maximum Sensitivity modes. Use the Normal Sensitivity setting for typical monitoring purposes. Use the APOD setting where there is a high probability of the sensor becoming detached. Use the Maximum Sensitivity setting for patients with low perfusion or when the low perfusion message is displayed on the screen in APOD or normal sensitivity mode. The default is APOD. ***Note:*** When using the Maximum Sensitivity setting, the SENSOR OFF detection performance may be compromised ***Note:*** In "Custom" mode (see Section 4, Operation) the unit will remain in Normal or APOD setting after a power cycle. Maximum Sensitivity will automatically reset to Normal Sensitivity after a power cycle. In "Neo" or "Adult" mode (see Section 4, Operation) the unit will reset the sensitivity to the hospital specified setting (Normal or APOD) after a power cycle.
ROTATE DISPLAY	Press the Rotate Display button to reconfigure the display screen in a vertical or horizontal format. The display rotates counter-clockwise in 90 degree increments.

SECOND PAGE

NEXT MENU PAGE	Press the Next Menu Page button to access the first page of selections. Press and hold for 6 seconds to toggle between Traditional User Interface and the Simplified User Interface. Enter password when prompted. The Radical will retain this setting after a power cycle.
ALARM MENU	Press the Alarm Menu Access button to enter the alarm settings menu.
INCREASE LOUDNESS	Press the Increase Loudness button to increase the volume of the pulse beep. Seven levels of volume exist.
DECREASE LOUDNESS	Press the Decrease Loudness button to decrease the volume of the pulse beep. The lowest volume level will silence the pulse beep.

Navigating the main menu

When the main menu is accessed, the plethysmograph and Signal IQ waveform displays are replaced with the main menu items. The touch key icons, displayed along the right edge of the LCD display, are also replaced by the menu access icons. When the main menu is accessed the monitor remains functional and the saturation and pulse rate numbers will continue to be displayed.

MAIN MENU SELECTION

The top menu category uses the following four menu selections and touch key control buttons and icons.

	EXIT	Select the Exit icon to exit the main menu.
	SELECT CATEGORY	Select the Select Category icon to select the highlighted menu item and enter the next level menu.
	PREVIOUS	Select the Previous icon to scroll through the menu items without selecting them. Once a menu item is highlighted, enter the menu by pressing the Select Category icon.
	NEXT	Select the Next icon to scroll through the menu items without selecting them. Once a menu item is highlighted, enter the menu by pressing the Select Category icon.

MENU CATEGORIES

Once a menu category has been selected, a new set of menu selections and icons are displayed.

	EXIT	Select the Exit icon to exit the menu category and return to the previous menu.
	EDIT PARAMETER	Select the Edit Parameter icon to select the highlighted parameter for editing.
	PREVIOUS	Select the Previous icon to scroll through the parameters. Once a parameter is highlighted, edit the parameter by pressing the Edit Parameter icon.
	NEXT	Select the Next icon to scroll through the parameters. Once a parameter is highlighted, edit the parameter by pressing the Edit Parameter icon.

EDITING A PARAMETER

Once a parameter has been selected for editing, a new set of menu selections and icons are displayed.

	EXIT	Select the Exit icon to exit the parameter without making the new selections permanent.
	ACCEPT	Select the Accept icon to save the changes.
	PREVIOUS	Select the Previous icon to increase or toggle the parameter settings.
	NEXT	Select the Next icon to decrease or toggle the parameter settings.

MENU TREE

This section gives an overview of the menu selections that are available. To navigate through the menus, use the touch key icons and control buttons located on the front panel of the Handheld, to the right of the LCD display. The following sub-sections describe each menu item in more detail.

ALARMS	% SpO_2 high/low limit
	Pulse rate high/low limit (bpm)
	Silence
	Volume
	Delay
	Mode

DISPLAY	View
	Trend
	Contrast
	Language
	Default

GENERAL	Averaging Time
	FastSat
	Home Use
	Interface Alarms
	SatShare Numbers
	Power Save
CLOCK	Time (hour/minute/seconds)
	Time display format
	Day
	Month
	Year
	Format
ABOUT	Software Version
CONFIG	Rapid Desat Limit
OUTPUT	Serial
	Analog 1
	Analog 2
	Nurse Call
	Polarity
SERVICE	Handheld Battery Deep Discharge
	DS Battery Deep Discharge

Alarms

Check alarm limits each time the pulse oximeter is used to ensure that they are appropriate for the patient being monitored. An audible alarm and a flashing alarm icon (and indicator light) will occur when an alarm limit is met or exceeded.

MENU ITEMS	DESCRIPTION
SpO_2 HIGH LIMIT	The SpO_2 high alarm limit can be set anywhere between 2% and 100%, with a 1% step size. In the "----" (off) setting, the alarm can be turned off completely.
SpO_2 LOW LIMIT	The SpO_2 low alarm limit can be set anywhere between 1% and 100%, with a 1% step size. ***NOTE:*** *The low alarm limit always has to be set below the high alarm setting. When the high alarm limit is set below the low alarm limit, the low alarm limit will automatically adjust to the next setting below the newly entered high alarm limit setting.* ***NOTE:*** *The SpO_2 low limit can not be set below the password protected minimum low SpO_2 alarm limit. See Section 4, Operation, Display for details..*
PULSE RATE HIGH LIMIT (BPM)	The pulse rate high alarm limit can be set anywhere between 30 BPM and 240 BPM, with a 5 BPM step size.
PULSE RATE LOW LIMIT (BPM)	The pulse rate low alarm limit can be set anywhere between 25 BPM and 235 BPM, with a 5 BPM step size. ***NOTE:*** *The low alarm limit always has to be set below the high alarm setting. When the high alarm limit is set below the low alarm limit, the low alarm limit will automatically adjust to the next setting below the newly entered high alarm limit setting.*

Alarms (con't.)

MENU ITEMS	DESCRIPTION
SILENCE	This menu allows the user to set the alarm silence period. An alarm is silenced by pressing the Alarm Silence button on the front panel. **30, 60, 90,120 SECONDS** The alarm silence can be set for these durations. As an indicator that the alarm system is silenced, the Alarm Status Indicator is shown as a bell with a slash through it. A timer is shown next to the bell indicating the remaining alarm silence duration. ***NOTE:*** *The alarm silence period is reset to 120 seconds (or 90 seconds in neonatal mode) upon power cycle, except for when the Radical is set to operate in the Home mode.* **ALL MUTE** All patient alarm conditions are silenced. Only system alarms will be indicated by an audible alarm. As an indicator that the system is set to All Mute, the Alarm Status Indicator is shown as a bell with a slash through it. **ALL MUTE WITH AUDIBLE REMINDER** All patient alarm conditions are silenced. Only system alarms will be indicated by an audible alarm. As a reminder, a single audible alarm will occur every three minutes. As an indicator that the system is set to All Mute the Alarm Status Indicator is shown as a bell with a slash through it.

WARNING: IF AN ALARM CONDITION OCCURS WHILE THE ALARM SILENCE PERIOD IS SET TO ALL MUTE, THE ONLY ALARM INDICATIONS WILL BE VISUAL DISPLAYS AND SYMBOLS RELATED TO THE ALARM CONDITION. NO ALARM TONE WILL SOUND.

Alarms (con't.)

MENU ITEMS	DESCRIPTION
VOLUME	This menu allows the user to set the alarm volume. Four levels are available: level 1 being the softest and level 4 being the loudest. The device retains the Alarm Volume setting upon a power cycle. ***NOTE:*** *For home use, set the alarm level to level 4.*
DELAY	This menu allows the users to set an audible saturation delay. The delay can be set to either 0, 5 or 10 seconds. The delay setting only affects saturation alarms indications. ***Note:*** In "Custom" mode (see Section 4, Operation) the unit will retain the Alarm Delay setting after a power cycle.In "Neo" or "Adult" mode (see Section 4, Operation) the unit will reset the Alarm Delay to the hospital specified setting after a power cycle.
MODE	The Radical stores three types of modes: Adult, Neonatal or Custom limits. Adult and Neonatal must be initially set and enabled (via password protected screen) before they can be selected. **CUSTOM** Any changes to settings on the Alarm menu will be retained after a power cycle.* **ADULT** Any changes to settings on the Alarm menu will be reset to pre defined Adult defaults after a power cycle.† **NEO** Any changes to settings on the Alarm menu will be reset to pre defined Neonatal defaults after a power cycle.†

TYPES	SpO_2 (HIGH)	SpO_2 (LOW)	PULSE RATE (HIGH)	PULSE RATE (LOW)
ADULT LIMITS†	Off	90%	140 BPM	50 BPM
NEONATAL LIMITS†	100%	90%	180 BPM	100 BPM
CUSTOM LIMITS*	Off*	90%*	140 BPM*	50 BPM*

NOTE: *Limits are set at the factory to the values listed in this table.*

**Once Custom values are changed by the user, they will be retained after a power cycle.*

†Adult and Neo settings can be changed (via a password protected screen) to specific hospital/unit requirements. In enabled, any values changed by the user will be returned to the default values after a power cycle

Display

MENU ITEMS	DESCRIPTION
VIEW	Three views are available: Pleth and Signal IQ, Numbers and Pleth Only. **PLETH + SIGNAL IQ** Shows the SpO_2 and pulse rate numbers on the left or top of the screen, and the plethysmograph and Signal IQ waveform on the right or bottom of the screen. The Screen also indicates the signal strength of the measured signal as a perfusion index (PI). The PI is calculated as the relation of arterial pulsatile signal to the non-pulsatile signal component. **PLETH ONLY** Shows the SpO_2 and pulse rate numbers on the left or top of the screen,and the plethysmograph waveform on the right or bottom of the screen. The Screen also indicates the signal strength of the measured signal as a perfusion index (PI). The PI is calculated as the relation of arterial pulsatile signal to the non-pulsatile signal component. **NUMBERS** Shows the SpO_2 and pulse rate numbers and the signal IQ in the form of a pulse bar on the screen. The Screen also indicates the signal strength of the measured signal as a perfusion index (PI). The PI is calculated as the relation of arterial pulsatile signal to the non-pulsatile signal component.
TREND	Allows the user to select and view the Trend Display between SpO_2 and pulse rate (%SpO_2 - BPM), perfusion index and pulse rate (PI - BPM) or SpO_2 and perfusion index (%SpO_2 - PI).
CONTRAST	Allows the user to set the contrast of the LCD display. Contrast ranges from 0 to 63. ***NOTE:*** *The contrast can also be set by pressing and holding the Backlight/ Contrast Button on the front panel.*
LANGUAGE	Allows the user to select the language displayed on the screen.
DEFAULT	Allows the user to select user mode or reset the settings to factory defaults. ***NOTE:*** *A password is required to access these menu options.* **SAVE LAST** This allows the user to either use Custom setting or Adult/Neonatal settings. Select "Yes" to use custom settings. **SAVE AS ADULT** Store current settings as Adult default setting. **SAVE AS NEO** Store current settings as Neonatal default setting. **RESTORE FACTORY** Recall factory setting for Custom, Adult and Neonatal. **LOW % SpO_2 LIMIT** Allows the user to set a custom default minimum low SpO_2 limit. The unit will return to this setting after a power cycle.

General

MENU ITEMS	DESCRIPTION
AVERAGING TIME	The signal averaging time of this device can be set to: 2, 4, 8, 10, 12, 14 and 16 seconds*. *With FastSat the averaging time is dependent on the input signal. For the 2 and 4 second settings the averaging times may range from 2-4 and 4-6 seconds, respectively.
FASTSAT	Select "Yes" to activate the FastSat algorithm. In the 2 and 4 seconds averaging mode, the FastSat algorithm is automatically enabled.
HOME USE	Set the Radical to the Home Mode. The Radical will remain in the Home Mode until the "No" setting is selected. A password is required to activate or deactive this mode. See Section 4, *Home Mode Operation*, for a detailed description.
INTERFACE ALARMS	During SatShare, HP Vuelink, Spacelabs Flexport and RadNet operation, the audible alarms can be enabled or disabled.
SATSHARE NUMBERS	During SatShare operation the saturation and pulse rate measurements can be displayed on the Radical by selecting a SatShare Numbers setting of "Yes".
POWER SAVE	Select "Yes" to maximize battery-operating time of the Radical while powered by the Handheld battery or optional Docking Station battery. Selecting "Yes" will disable Docking Station functions such as SatShare, Serial and Analog output. Selecting "No" will activate these Docking Station functions while operating on battery power. (While operating in the Power Save mode, a power cycle of the Radical may be required to activate the Docking Station again after it has been disabled.)

Clock

MENU ITEMS	DESCRIPTION
TIME	Set the time - hour, minutes and seconds - in 24 hour format.
TIME FORMAT	Set the format of the time display as it will be shown on the front panel. Available options are 12 hour (default) and 24 hour display.
DATE	Set the date (day, month and year).
DATE FORMAT	Set the format of the date display as it will be shown on the front panel. Available options are mm/dd/yy (default) and dd/mm/yy.

About

This displays the copyright and software versions of the Handheld and Docking Station.

Config

MENU ITEMS	DESCRIPTION
RAPID DESAT LIMIT	The Rapid Desat Limit will ignore the Alarm Delay setting if desaturation falls below the Low SpO_2 alarm threshold per a user-defined percentage. Audible tones are generated immediately, along with all visual indicators. The Rapid Desat Limit can be set to the following: **OFF:** The Alarm Delay setting will delay audible alarm tones regardless of how deep the desaturation is below the alarm threshold. **-5:** The Alarm Delay setting is ignored if the desaturation is 5% (meaning 5 saturation units) below the Low SpO_2 alarm threshold. **-10:** The Alarm Delay setting is ignored if the desaturation is 10% (meaning 10 saturation units) below the Low SpO_2 alarm threshold.

Output

Note: *The output menu selections are only available when the Radical Handheld is interfaced to the Docking Station.*

MENU ITEMS	DESCRIPTION
SERIAL	The following serial output modes are supported. All serial output is RS-232 based. See the interface specifications in Section 7, Specifications. **ASCII 1** ASCII text data is sent to the serial interface at one-second intervals. The ASCII text includes: date and time stamp, SpO_2 pulse rate, PI, and alarm and exception values. All text is single line followed by a line feed character and a carriage return. **ASCII 2** ASCII text data is sent to the serial interface following a query from the connecting computer. RadNet data output is in this format. **BINARY** Compressed binary data is sent to the serial interface following a query from the connecting computer. **PHILIPS VUELINK** SpO_2, pulse rate and plethysmographic waveform data are sent in Philips VueLink format to the serial port. **SPACELABS FLEXPORT** SpO_2, pulse rate and plethysmographic waveform data are sent in Spacelabs Flexport format to the serial port.
ANALOG1 OR ANALOG 2	**SpO_2 0 - 100%** Scales the saturation measurement with 0% being equal to 0 Volt and 100% equal to 1 Volt. **SpO_2 50 - 100%** Scales the saturation measurement with 50% being equal to 0 Volt and 100% equal to 1 Volt. **PULSE RATE** Scales the pulse rate measurement with 0 BPM being equal to 0 Volt, and 250 BPM equal to 1 Volt.

Output (con't.)

MENU ITEMS	DESCRIPTION
ANALOG1 OR ANALOG 2 (CONTINUED)	**Pleth** Traces the plethysmographic waveform as shown on the Radical display. **Signal IQ** Traces the Signal IQ waveform as shown on the Radical display. A full scale Signal IQ signal (100%) is represented as 1 Volt, while a zero Signal IQ signal (0%) is represented as 0 Volt. **0V Output** A 0 Volt calibration signal is mapped to the analog output. Use this signal for calibration of recording devices. (0 Volts represents a saturation of 0% and a pulse rate of 0 bpm). **1V Output** A 1 Volt calibration signal is mapped to the analog output. Use this signal for calibration of recording devices. (1 Volt represents a saturation of 100% and a pulse rate of 250 bpm).
NURSE CALL	**Alarms** The nurse call output will be activated based on alarm events. **Low Signal IQ** The nurse call output will be activated based on Low Signal IQ events. **Alarm & Signal IQ** The nurse call output will be activated based on alarm and Low Signal IQ events.
POLARITY	**Normal** Standard polarity. See section 7, *Analog output / nurse call specifications*. **Invert** This setting reverses the Normally Open and Normally closed contacts. See section 7, *Analog output / nurse call specifications*.

CAUTION: TO AVOID EXCESSIVE BATTERY DISCHARGING, DO NOT CONNECT ANY EQUIPMENT TO THE SERIAL PORT ON THE BACK PANEL UNLESS THE RADICAL IS CONNECTED TO THE AC MAINS POWER SUPPLY.

Service

NOTE: *The Service menu selections are only available when the Radical Handheld is interfaced to the Docking Station.*

Only qualified Biomedical or Clinical Engineering department personnel should access the service menu. See Section 4, *Password Operation*, on how to enter the password.

MENU ITEM	DESCRIPTION
HANDHELD BATTERY DISCHARGE	To deep discharge the Handheld battery select this menu item. See Section 9, *Battery Operation and Maintenance*, for more information.
DS BATTERY DISCHARGE	To deep discharge the optional Docking Station battery select this menu item. See Section 9, *Battery Operation and Maintenance*, for more information.

The discharge cycle will take approximately 16 hours to complete for the Handheld battery. The Docking Station battery will take approximately 30 hours to complete. A message will appear in the service screen when the discharge cycle is complete. The batteries will be fully charged after completion of the cycle.

When deep discharge is started, the backlight will automatically turn down to the default handheld battery powered level. Wait until the message changes from (In Progress) to (Done).

NOTE: *In order for the discharge cycle to be properly completed, AC power must be supplied to the instrument throughout the cycle.*

WARNING: WHEN DEEP-DISCHARGING THE HANDHELD OR DOCKING STATION BATTERY, MAKE SURE THAT THE DEVICE HAS BEEN REMOVED FROM SERVICE UNTIL FULL BATTERY CAPABILITY CAN BE RESTORED.

Trend display

Once the Trend Display touch key icon is selected the trend data is displayed on the main screen. The Radical stores one data set of SpO_2, pulse rate, PI and system messages in a dedicated memory area. Depending on the Trend Period, a setting for how often the data is stored in the trend memory, the Radical can store between 87 hours and 18 days of trend data. The Radical also employs a sophisticated data compression scheme. The actual amount of trend data that is stored is dependent on the type of data that is collected.

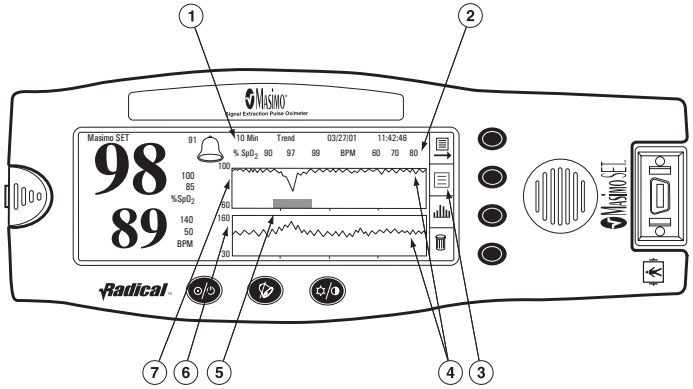
The Radical only stores data in the trend memory while the device is turned on, and the trend data remains in memory until the memory fills up, or is cleared by the user.

CAUTION: CHANGING THE DATE AND TIME OF THE SYSTEM CLOCK, OR CHANGING THE TREND PERIOD, WILL ALSO CLEAR THE DATA IN THE TREND MEMORY.

The following table outlines the trend capacity for sample Trend Period settings:

TREND PERIOD	TREND MEMORY CAPACITY
2 SECONDS	MINIMUM OF 87 HOURS (~3.5 DAYS)
10 SECONDS	TYPICALLY 435 HOURS (~18 DAYS)

The Trend display can be configured to display any two of the three available trend parameters (SpO_2, pulse rate or PI). The unit is storing all 3 parameters in trend memory, but can only disply 2 parameters at any one time. The Trend Display can be adjusted to the desired parameter by Selecting *Trend* from the *Main, Display* Menu.



1	The top line on the trend display shows the time scale of the trend graph, followed by the starting date, starting time and end time of the data set that is displayed on the screen.
2	The second line of the display shows the minimum, average, and maximum SpO_2 , PI or pulse rate measurements contained in the displayed data set (excluding zero measurements).
3	The vertical scale of the SpO_2, PI or pulse rate graphs can be set in the Trend Setup menu.
4	A dark line on the trend graph indicates the averaged data, while grayed-out data points show minimum and maximum values.
5	A grayed-out box or line located on the bottom axis of the saturation graph indicates a period of time for which the Low Signal IQ indicator was active, indicating the signal quality was very low and the accuracy of the measurement may have been compromised.
6 7	The available trend graphs show two of the desired trend parameter measurements displayed versus time.

By default, the trend display automatically refreshes, at a rate of once every 10 seconds, to show the latest measured SpO_2, PI or pulse rate data. This feature is only available while the trend view is 2 hours or less, and the latest measured data is shown. If the user scrolls through the data set to display previously recorded trend data, or if the trend scale is greater than 2 hours, the trend display will time out after 1 minute of inactivity (i.e. the user does not press any of the touch key control buttons) and the normal Radical display will be shown.

NAVIGATING THE TREND DISPLAY

In the Trend Display view there are a total of 10 touch key icon selections on 3 pages of menu selections. These menu screens are not accessable when using the Simplified User Interface.

FIRST PAGE

NEXT MENU PAGE	Press the Next Menu Page button to access the next page of menu selections.
EXIT	Press the Exit button to return to the normal display screen.
SCROLL RIGHT	Press the Scroll Right button to scroll through the data set. The display scrolls by ½ the selected time scale. For example if a 2 hr display view is selected, then pressing the Scroll Right button will scroll the displayed data by 1 hr to the right.
SCROLL LEFT	Press the Scroll Left button to scroll through the data set. The display scrolls by ½ the selected time scale. For example if a 2 hr display view is selected, then pressing the Scroll Left button will scroll the displayed data by 1 hr to the left.

SECOND PAGE

NEXT MENU PAGE	Press the Next Menu Page button to access the next page of menu selections.
ZOOM	Press the Zoom button to change the time scale of the trend view. The available time scales are 24 hrs, 12 hrs, 8 hrs, 4 hrs, 2 hrs, 1 hr, 30 minutes, 10 minutes, 1 minute and 20 seconds. The Zoom button uses the last recorded data point as the zoom reference point. In other words, the last recorded data point is always shown as the right-most data point on the display.
ZOOM FROM LEFT	Press the Zoom from Left button to zoom into the data set while keeping the data point that is shown on the right side of the trend graph as the zoom reference point.
ZOOM FROM RIGHT	Press the Zoom from Right button to zoom into the data set while keeping the data point that is shown on the left side of the trend graph as the zoom reference point.

THIRD PAGE

NEXT MENU PAGE	Press the Next Menu Page button to return to the first page of menu selections.
TREND SETUP	Press the Trend Setup button to enter the Trend Setup Menu.
HISTOGRAM	Press the Histogram button to display the selected data set (the data set shown in the trend view) in histogram format.
CLEAR TREND DATA	Press the clear Trend Data button to clear the data stored in the trend memory.

TREND SETUP

This menu allows the user to set the default trend settings and to clear the trend data, or download the trend data to the serial port. The default settings are used to scale the trend graphs when the trend data button, located on the main display, is accessed.

MENU ITEMS	DESCRIPTION
%SpO_2 HIGH SCALE	Sets the high scale of the SpO_2 trend graph.
%SpO_2 LOW SCALE	Sets the lower scale of the SpO_2 trend graph.
PR HIGH SCALE (BPM)	Sets the high scale of the pulse rate trend graph
PR LOW SCALE (BPM)	Sets the low scale of the pulse rate trend graph
PI HIGH SCALE	Sets the high scale of the PI trend graph
PI LOW SCALE	Sets the low scale of the PI trend graph
DEFAULT VIEW	Selects the default time scale of the trend view. This setting only selects the time scale of the trend view when the trend data is initially displayed, (i.e. when the trend data is initially accessed). The selections are 24 hrs, 12 hrs, 8 hrs, 4 hrs, 2 hrs, 1 hr, 30 minutes, 10 minutes, 1 minute and 20 seconds.
TREND ACTION	**SERIAL DUMP** To send all the data that is stored in trend memory to the serial port select the Serial Dump option. Use this option to communicate the stored data set to trend graphing software applications. **ANALOG DUMP** To send all the data that is stored in the trend memory to the analog output select the Analog Dump option. Use this option to print the trend information on an analog chart recorder. **PRINT** To print the trend data that is shown in the Trend View select the Print option. The trend data is first printed in histogram format, followed by a table of data that shows the time and date stamp of a trend record, and the SpO_2, PI and pulse rate measurement. Each trend record is printed on a single line, followed by a carriage return and line feed character.

MENU ITEM	DESCRIPTION
TREND PERIOD	The Trend period setting determines how often a set of SpO_2, PI and pulse rate data points is stored in trend memory. A setting of 2, for example, sets the Radical to store one set of SpO_2, PI and pulse rate measurements every 2 seconds, resulting in a minimum trend capacity of 87 hours. A setting of 10, for example sets the Radical to store one set of data points every 10 seconds, resulting in a typical trend storage capacity of 18 days.

NOTE: *Since the Radical employs a sophisticated data compression scheme the actual trend capacity is dependent on the type of data that is collected.*

Backlight/contrast operation

The backlit LCD screen of the Radical Handheld can be set to four levels of illumination, in addition to no illumination, when Radical operates as a standalone pulse oximeter. The Radical temporarily indicates the illumination level on the display following a change in illumination level. To select the level of illumination simply press the Backlight/Contrast button located on the front panel of the Handheld.

When the Radical Handheld unit is released from the Docking Station the illumination of the LCD screen automatically reverts to the lowest level to conserve battery power. To select a different level of illumination, press the Backlight/Contrast button again. In the Handheld mode, three levels of illumination are available.

When the Handheld unit is re-attached to the Docking Station, as well as when the Radical is powered on in the Standalone configuration, the backlight is automatically set to the maximum illumination when the unit is AC line powered.

To change the contrast of the LCD screen, select the Contrast parameter of the Display menu. While changing the contrast setting, the screen will refresh to reflect the current setting.

The contrast of the LCD screen can also be changed by depressing and holding the Backlight/Contrast button located on the front panel of the Handheld. While holding the Backlight/Contrast button, the screen will refresh to reflect the current setting. Release the button at the desired setting.

Satshare operation

When the SatShare cable is connected to the Radical and to a multiparameter patient monitor, the Radical automatically starts to operate in the SatShare mode.

In the SatShare mode, Radical operates as follows:

- All visual alarms remain active.
- All audible alarms may be disabled by software configuration of the Radical.
- The SpO_2 and pulse rate numbers may or may not be displayed on the Radical display depending on the SatShare Numbers setting of the General menu.
- All other items are displayed, including the alarm limits, the plethysmogram and Signal IQ waveform.
- The user can access the menu system.
- If the SatShare cable is connected to the Radical only, and not to a patient monitor, the SatShare cable type is flashing on the LCD screen.
- Once Radical detects the presence of a patient monitor, the SatShare cable type remains constantly displayed on the LCD screen.
- Patient Alarms of the multiparameter patient monitor will be triggered by the alarm setting of the patient monitor and not the Radical. To synchronize the alarm events set the alarm limits of the Radical to those of the patient monitor, or vice versa.
- Once Radical detects that the SatShare cable is disconnected from the patient monitor, or if the patient monitor is turned off, Radical automatically returns to normal, standalone operation.
- In the SatShare mode, the pulse beep tone of the Radical is initially set to the lowest volume (mute). The pulse beep volume can be manually increased.
- The Radical may automatically set the averaging time during SatShare operation. For averaging times of 10 seconds and higher, the Radical will automatically set the averaging time to 8 seconds during SatShare operation. Averaging times of 2, 4 or 8 seconds remain unchanged during SatShare operation. When the Radical returns to non-SatShare operation, the Radical will maintain the averaging time setting used in the SatShare mode.
- When the Radical starts to operate in the SatShare mode the sensitivity mode is set to Normal sensitivity. The sensitivity mode can manually be set to Maximum or APOD sensitivity.
- While operating in the SatShare mode, the Radical may automatically disable the SatShare interface if the perfusion index drops below 0.1% while the sensitivity is set to Max sensitivity. To enable the SatShare interface again, set the Radical to the Normal or APOD sensitivity mode, increase the perfusion at the measurement site (by warming the patient or sensor site), or move the sensor to a site with better perfusion

.

CAUTIONS:

- SATSHARE SIGNALS ARE IDEAL SIMULATED WAVEFORMS CORRESPONDING TO THE CALCULATED SATURATION AND PULSE RATE VALUES AND DO NOT CONTAIN ALL OF THE INFORMATION CONTAINED IN PHYSIOLOGICAL WAVEFORMS. THE MULTIPARAMETER PATIENT MONITOR DECODES THESE SIGNALS INTO SATURATION AND PULSE RATE VALUES.
- DURING SATSHARE OPERATION, THE AUDIBLE ALARMS MAY BE MUTED ON RADICAL. WHEN THE AUDIBLE ALARM IS MUTED (INDICATED BY BELL WITH SLASH THROUGH IT) ON RADICAL, USE THE MULTIPARAMETER MONITOR FOR AUDIBLE ALARM INDICATION.
- DURING SATSHARE OPERATION DO NOT USE THE PLETH WAVEFORM DISPLAY ON THE MULTIPARAMETER MONITOR FOR DIAGNOSTIC PURPOSES. INSTEAD, USE THE PLETH WAVEFORM DISPLAYED ON THE RADICAL SCREEN.
- TO AVOID EXCESSIVE BATTERY DISCHARGING, DO NOT CONNECT ANY EQUIPMENT TO THE SATSHARE CONNECTOR UNLESS THE RADICAL IS CONNECTED TO THE AC MAIN POWER SUPPLY.
- TO ENSURE THAT THE SAFETY LEVEL DURING DEFIBRILLATION IS MAINTAINED, MAKE SURE THAT THE SATSHARE CABLE CONNECTOR IS PROPERLY SECURED AT THE DOCKING STATION.
- ONLY USE A SATSHARE CABLE THAT HAS A FERRITE BEAD INSTALLED.

To return from SatShare operation to normal standalone operation, simply disconnect the SatShare cable from the patient monitor or disconnect the SatShare cable from the SatShare connector on the back of the Radical.

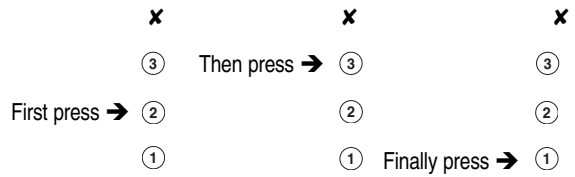
Home mode operation

The Radical can be placed into the Home Mode to protect unqualified users from changing the Radical alarm settings and operation. Entering a password does not automatically reset the Radical to the Normal operating mode. In the Home Mode, a password is required to access the menu system and the touch key control buttons and icons.

NOTE: *When the Radical is set to operate in the Home mode the default values that the Radical reverts to after a power cycle are set according to Section 3, Monitor Setup, with the exception of the Alarm Silence setting, which is set to the pre-power down setting.*

Password operation

The Radical password is 2-3-1. To enter the password use the touch-key control buttons to the right or bottom of the LCD display and press the buttons in the sequence shown in the following figure:



To return to normal operating mode set the General/Home Use parameters to “No”.

Introduction

The following section outlines system alarms and messages displayed on the LCD screen.

Please become thoroughly familiar with this information before operating the pulse oximeter.

Alarm identification

The Radical visually and audibly indicates alarm conditions that the system detects. The integrated loudspeaker indicates alarm conditions audibly. The LCD screen and the LED lights on the Docking Station indicate the visual alarms. Audible alarms may be silenced, without affecting the operation of visual alarms.

Three levels of alarm priority are implemented: high, medium and low priority. The following table outlines the alarm priority specifications.

ALARM	DESCRIPTION
HIGH PRIORITY	Audible and visual alarms for low saturation (SpO_2 range 1-100%) and pulse rate (pulse rate range 25-240 bpm). Audible and visual alarms for system failures. Sensor Failure and Disconnect.
MEDIUM PRIORITY	Audible and visual alarms for high saturation (SpO_2) Audible and visual alarms for Desat Index (See 3D Alarm System option) Audible and visual alarms for Perfusion Index Delta (See 3D Alarm System option)
LOW PRIORITY	Audible and visual alarms for low battery.

NOTE: *High priority alarms indicate that immediate operator response is required. Low priority alarms indicate that operator awareness is required.*

System messages

The following chart alphabetically lists all system messages displayed on the LCD screen. The cause of the message, and the action(s) to be taken are also shown.

The operator should become thoroughly familiar with this information before using the oximeter for patient monitoring.

MESSAGE	POSSIBLE CAUSE(S)	RECOMMENDATION
AMBIENT LIGHT	Too much light on patient (sensor). Inadequate tissue covering sensor detector.	Remove or reduce lighting. Cover sensor from light. Reposition sensor.
DEFECTIVE SENSOR	Oximeter cannot identify the connected sensor the sensor has failed.	Broken sensor cable wire or inoperative LEDs or faulty detector; Replace sensor. Refer to the instructions for the sensor being used.
INTERFERENCE	Outside signal or energy preventing reading.	Remove outside interference.
INVALID SENSOR	Oximeter cannot identify the connected sensor	Broken sensor cable wire or inoperative LEDs or faulty detector; the sensor has failed. Replace sensor. Refer to the instructions for the sensor being used.
LOW BATTERY	Battery charge is low.	Charge battery by placing the Radical Handheld into the Docking Station and powering the unit with AC line power. Replace battery if necessary.
LOW PERFUSION	Signal too small.	Move sensor to better perfused site. Refer to Section 4, *Low Perfusion*.
LOW SIGNAL IQ	Low signal quality.	Ensure proper sensor application. Move sensor to a better perfused site. Refer to Section 4, *Signal IQ*.

Alarm operation

The Radical audibly alarms when the saturation measurement or pulse rate measurement exceeds the low or high saturation or pulse rate alarm limits. The Radical allows a user to delay audible saturation alarms by 0, 5 or 10 seconds, by selecting the appropriate setting in the Alarm - Delay menu.

A delayed saturation alarm is visually indicated by a flashing alarm bell on the Radical display, and a flashing saturation and alarm limit indicator. An active alarm condition is visually indicated by a flashing alarm bell, a flashing saturation and alarm limit indicator on the Radical display, and a flashing red alarm indicator on the Docking Station. Saturation changes of greater than 5% in excess of the alarm limit are indicated immediately, regardless of alarm delay setting. In addition, alarms are audibly indicated according to the Alarm Silence / mute setting in the Alarms menu.

Alarm messages

Alarm messages indicate a problem or condition, which may affect accurate monitoring values. Do not ignore these messages. Correct any fault before continuing.

Press the Alarm Silence key to temporarily silence the audible alarm. Alarm messages and violating values flash on the display, and the Docking Station front panel alarm indicator flashes red if the Handheld unit is in the Docking Station. If the measurement returns to within limits, the alarm turns off.

A list of alarm conditions that cause audible and visual alarm indications and the displayed alarm messages are shown in the following table. The reason of why these alarms might occur is also shown.

MESSAGE	DESCRIPTION
SENSOR OFF	The sensor is not properly attached to the patient.
NO SENSOR	The sensor is not properly attached to the monitor.
SpO_2 HIGH	The high SpO_2 rate limit has been exceeded.
SpO_2 LOW	The low SpO_2 rate limit has been exceeded..
PR HIGH	The high pulse rate limit has been exceeded.
PR LOW	The low pulse rate limit has been exceeded.

MESSAGE	POSSIBLE CAUSE(S)	RECOMMENDATION
NO SENSOR	Sensor not fully inserted into the connector.	May be an incorrect sensor, or a defective sensor or cable. Insert sensor into connector. Disconnect and reconnect sensor. Refer to the instructions for the sensor being used.
	Unit is searching for patient's pulse.	Disconnect and reconnect the sensor with the logos matching.
PULSE SEARCH	Unit is searching for patient's pulse.	If values are not displayed within 30 seconds, disconnect and reconnect sensor. If pulse search continues, remove sensor and replace on a better perfused site.
SENSOR OFF	Sensor off patient.	Disconnect and reconnect sensor. Reattach sensor.
DEFECTIVE SENSOR	Broken sensor cable wire or inoperative LEDs or faulty detector	Replace sensor. Refer to the instructions for the sensor being used.
SERVICE REQUIRED*	Internal Failure.	Unit requires service.

* The SERVICE REQUIRED message fills the entire display.

Troubleshooting

The following chart describes what to do if the Radical system does not operate properly or fails.

PROBLEM	POSSIBLE CAUSE(S)	RECOMMENDATION
UNIT DOES NOT POWER ON.	One or both of the fuses have blown.	Replace the fuses.
UNIT POWERS ON BUT THE GRAPHIC DISPLAY IS BLANK.	The viewing contrast is not correct.	Use the Backlight/Contrast button to adjust the viewing angle. If the condition persists, the unit requires service.
CONTINUOUS SPEAKER TONE.	Internal failure.	Unit requires service. Press the Alarm Silence button to silence the alarm. If alarm continues to sound, power down unit and remove Handheld battery if necessary.
BUTTONS DON'T WORK WHEN PRESSED	Internal failure.	Unit requires service.

The following chart describes what to do when encountering common problems:

PROBLEM	POSSIBLE CAUSE(S)	RECOMMENDATION
HANDHELD BATTERY DOES NOT CHARGE	AC power cable may be disconnected.	Restore power to the device.
PRINT FUNCTION DOES NOT WORK	Wrong serial cable is used.	Make sure a null modem cable is used.
LED LIGHTS ON LEFT SIDE OF DOCKING STATION CONTINUOUSLY FLASH	Incompatable version of software on Radical handheld and docking station.	Upgrade to current software versions. Match handheld to docking station with compatable software versions.
BATTERY RUN-TIME IS SIGNIFICANTLY REDUCED	Memory effects	Use Battery Discharge function as described in Section 4, *Service.*

NOTE: *When a version R4 or later handheld is connected to a prior version docking station (R2.2 or earlier), the handheld component will continue to accurately monitor SpO_2 and pulse rate, however, certain Radical features normally accessed through the docking station, including SatShare, analog output and serial output will not be available to the user.*

Radical specifications

PERFORMANCE

measurement range

SpO_2:	1-100%
Pulse Rate:	25-240 beats per minute (bpm)
Perfusion:	0.02% - 20%

accuracy

Saturation	70% to 100%
No Motion[1]	
Adults, Pediatrics	±2 digits
Neonate	±3 digits
Motion	
Adults[2] , Pediatrics[2]	±3 digits
Neonate	±3 digits
Low Perfusion[3]	
Adults, Pediatrics	±2 digits
Neonate	±3 digits

Pulse Rate Accuracy

pulse rate:	25-240 bpm
No Motion[1]	
Adults, Pediatrics, Neonate	±3 digits
Motion[2,]	
Adults, Pediatrics, Neonate	±5 digits
Low Perfusion	
Adults, Pediatrics, Neonate	±3 digits

resolution

Saturation (%SpO_2)	1%
Pulse Rate (bpm)	1 bpm

ELECTRICAL

standalone

AC Power requirements:	100-240 VAC, 47-63 Hz
Power consumption:	55 VA
Fuses:	1 Amp, Fast Acting, Metric, (5x20mm), 250V

batteries

Handheld:	
Type:	NiMH
Capacity:	8 hours[4,5]
Charging time:	3 hours
Docking Station (RDS-1B, RDS-3B):	
Type:	NiMH
Capacity:	12 hours[4,5]
Charging time:	6 hours

ENVIRONMENTAL

Operating Temperature:	41°F to 104°F (5°C to 40°C)
Transport/Storage Temperature:	-40°F to 158°F (-40°C to +70°C)[5]
Operating Humidity:	5% to 95%, non-condensing
Operating Altitude:	1060 mbar to 500 mbar pressure, -1000 ft to 18,000 ft (-304 m to 5,486 m)

PHYSICAL CHARACTERISTICS

dimensions

Handheld:	8.9" x 3.3" x 2.1" (22.6 cm x 8.4cm x 5.3 cm)
Standalone:	3.5" x 10.5" x 7.7" (8.9 cm x 26.7cm x 19.6cm)

weight

Handheld:	1.3 lbs. (0.59 kg)
Docking Station (RDS-1, RDS-2, RDS-3, RDS-4):	2.5 lbs. (1.14 kg)
Docking Station (RDS-1B, RDS-3B):	4.11 lbs (1.86 kg)
Standalone (RDS-1, RDS-2, RDS-3, RDS-4):	3.8 lbs. (1.73 kg)
Standalone (RDS-1B, RDS-3B):	5.4 lbs. (2.45 kg)

trending

72 hours of trending at 2 second resolution, up to 30 days of trending at 10 second resolution , output to serial printer or other serial devices

modes

Averaging mode:	2, 4, 8,10, 12, 14 or 16 seconds[6]
Sensitivity:	Normal and Maximum[8] and APOD

alarms

Audible and visual alarms for high low saturation and pulse rate (SpO_2 range 1-100%, pulse rate range 25-240 bpm)

Sensor condition, system failure and low battery alarms

High Priority:	571 Hz tone, 5 pulse burst, pulse spacing: 0.250s, 0.250s, 0.500s, 0.250s, repeat time:10s
Medium Priority:	550 Hz tone, 3 pulse burst, pulse spacing: 0.375s, 0.375s, repeat time: 7s
Low Priority:	500Hz tone, 1 pulse burst, repeat time: 5s
Alarm Muted reminder:	500Hz tone, 2 pulse burst, pulse spacing 0.375s, repeat time: 3min.
Alarm Volume:	High Priority: 88.9 dB (max), Medium Priority: 88.9 dB (max), Low Priority: 88.7 dB (max)

display/Indicators

Data display: %SpO_2, pulse rate, pleth waveform, alarm status, trends, status messages, Signal IQ, perfusion index, APOD and FastSat

Display Color:	Blue
Type:	Backlit LCD
Pixels:	480 x 160 dots
Dot Pitch:	0.25 mm

output interface

SatShare (RDS-1, RDS-1B, RDS-4)

Serial RS-232 (RDS-1, RDS-1B, RDS-3, RDS-3B, RDS-4)

Nurse Call/Analog Output (RDS-1, RDS-1B, RDS-3, RDS-3B)

HP Vuelink, Spacelabs Universal Flexport, RadNet (RDS-1, RDS-1B, RDS-3, RDS-3B)

compliance

EMC Compliance:	EN60601-1-2, Class B
Equipment Classification:	IEC 60601-1 / UL 60601-1

Type of Protection:	Class 1 (on AC power), Internally powered (on battery power)
Degree of Protection-Patient Cable:	Type BF-Applied Part
Degree of Protection-SatShare Cable:	Type CF-Applied Part
Mode of Operation:	Continuous

[1] The Radical with LNOP Adt sensors has been validated for no motion accuracy in human blood studies on healthy adult male and female volunteers with light to dark skin pigmentation in induced hypoxia studies in the range of 70-100% SpO_2 against a laboratory oximeter and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population weight.

[2] The Radical with LNOP Adt sensors has been validated for motion accuracy in human blood studies on healthy adult male and female volunteers with light to dark skin pigmentation in induced hypoxia studies while performing rubbing and tapping motions, at 2 to 4 Hz at an amplitude of 1 to 2 cm and a non-repetitive motion between 1 to 5 Hz at an amplitude of 2 to 3 cm in induced hypoxia studies in the range of 70-100% SpO2 against a laboratory CO-Oximeter and ECG monitor. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.

[3] The Radical with SatShare has been validated for low perfusion accuracy in bench top testing against a Biotek Index 2 simulator and Masimo's simulator with signal strengths of greater than 0.02% and a % transmission of greater than 5% for saturations ranging from 70 to 100%. This variation equals plus or minus one standard deviation. Plus or minus one standard deviation encompasses 68% of the population.

[4] This represents approximate run time with backlight at minimum and Power Save mode, using a new, fully charged battery.

[5] If the batteries are to be stored for extended periods of time, it is recommended that they be stored between -20°C to +30°C, and at a relative humidity less than 85%. If stored for a prolonged period at environmental conditions beyond these limits, overall battery capacity may be diminished, and lifetime of the batteries may be shortened.

[6] With FastSat the averaging time is dependent on the input signal. For the 2 and 4 second settings the averaging time may range from 2-4 and 4-6 seconds, respectively.

[7] Maximum sensitivity mode fixes perfusion limit to 0.02%.

Serial interface specifications

The digital interface for serial communication is based on the standard RS-232 protocol.

The Radical by default always outputs ASCII1 text data through the serial port, unless the user selects a different output mode in the Output menu. To interface with the Radical and receive serial text data, simply connect a serial interface cable with a ferrite bead installed to the serial output connector located on the back of the Radical Docking Station.

NOTE: *The Radical serial interface is only available when the Radical Handheld is properly attached to the Radical Docking Station.*

NOTE: *The serial interface is not available in all versions of the docking station.*
Once serial communication is established, packets of data are communicated at 1 second intervals. The data packets contain: the date, time, SpO_2, pulse rate, perfusion index and alarm and exception values. (in ASCII format).

WARNING: ALL EXTERNAL DEVICE CONNECTIONS TO THE ANALOG OUTPUT/ NURSE CALL CONNECTOR MUST BE IEC-60950 COMPLIANT.

SERIAL INTERFACE SETUP

To interface with the Radical serial port, set the following communication parameters on the interfacing serial device:

PARAMETER	SETTING
BAUD RATE	9600 Baud bi-directional
NUMBER OF BITS PER CHARACTER	8
PARITY	None
BITS	1 start, 1 stop
HANDSHAKING	None
CONNECTOR TYPE	Female DB-9

The pin-outs for the RS-232 connector are shown in the following table:

PIN	SIGNAL NAME
1	No Connection
2	Receive data – RS-232 ±9 V (±5 Vmin)
3	Transmit data – RS-232 ±9 V (±5 Vmin)
4	No Connection
5	Signal Ground Reference for COM signals
6	No Connection
7	No Connection
8	No Connection
9	No Connection

SERIAL PRINTER SETUP

To print the SpO_2 and pulse rate data in ASCII1 format on a serial printer, simply connect the laser printer to the serial port. Once serial communication is established, the Radical will automatically start printing the ASCII1 text data.

WARNING: ALL EXTERNAL DEVICE CONNECTIONS TO THE RS-232 SERIAL PORT MUST BE IEC-60950 COMPLIANT.

Analog output / nurse call specifications

The Analog Out and Nurse Call are features accessible on the same female high density DB-15 connector.

NOTE: *The Radical analog output / nurse call interface is only available when the Radical Handheld is properly attached to the Radical Docking Station. Only use an analog / nurse call cable that has a ferrite bead installed.*

NOTE: *The analog output / nurse call interface is not available in all versions of the Docking Station.*

The following table shows the pinout of the analog output and nurse call.

PIN	SIGNAL NAME
1	+5V (60mA max.)
2	Ground
3	Ground
4	Ground
5	Ground
6	Nurse Call (Normally Open)
7	Nurse Call (Normally Closed)
8	Ground
9	Analog 1
10	Ground
11	Ground
12	Nurse Call – Common
13	Ground
14	Ground
15	Analog 2

ANALOG OUTPUT

The Radical can interface with various analog recording devices and/or strip chart recorders through its Analog Output connector located on the back of the Docking Station. Depending on the configuration of the Output menu, SpO_2, pulse rate, pleth waveform or Signal IQ parameters are output continuously on the Analog 1 and Analog 2 channels. The output signals vary from approximately 0 to 1 volt in a linear fashion.

NOTE: *The actual Analog 1 and Analog 2 output voltage that are generated may not exactly range between 0.0V to 1.0V. A variance of ± 40 mV is acceptable.*

CALIBRATION

For measurement device calibration purposes, the analog output signals can be set to either 0 Volts or 1 Volt in the menu system under Output/Analog Output Mode. Calibrate your analog recording system to those levels before use.

NURSE CALL

The nurse call feature is available when the Radical is operating in its standalone configuration. The nurse call feature on the Radical is based on the relay closing or opening depending on alarm, Low Signal IQ events or both. For maximum flexibility, either normally open (pin 6) or normally closed (pin 7) signals are available. Only qualified personnel should connect one of these two signals and common (pin 12) to a hospital's nurse call system. During an alarm condition, or a Low Signal IQ event, depending on the configuration of the output menu, the normally open pin will be connected to the common pin and the normally closed will be disconnected. In addition the nurse call polarity can be inverted to accommodate various nurse call stations requirements.

The nurse call relays have the following electrical specifications per switch:

PARAMETER	SPECIFICATION
MAX VOLTAGE	100VDC or AC peak
MAX CURRENT	100mA

WARNING: THE NURSE CALL FEATURE IS DISABLED WHEN THE AUDIBLE ALARMS ARE SILENCED WHILE THE NURSE CALL SETTING IN THE OUTPUT MENU IS SET TO "ALARMS".

Introduction

This section covers the use and cleaning of Masimo SET sensors and Masimo SET patient cables.

Masimo SpO_2 sensors

Before use, carefully read the sensor Directions for Use.

Use only Masimo oximetry sensors for SpO_2 measurements. Other oxygen transducers or sensors may cause improper Radical performance.

Tissue damage can be caused by incorrect application or use of a Masimo sensor, for example by wrapping the sensor too tightly. Inspect the sensor site as directed in the sensor Directions for Use to ensure skin integrity and correct positioning and adhesion of the sensor.

CAUTIONS:

- DO NOT USE DAMAGED SENSORS OR PATIENT CABLES. DO NOT USE A SENSOR OR PATIENT CABLE WITH EXPOSED OPTICAL OR ELECTRICAL COMPONENTS.
- DO NOT IMMERSE THE SENSOR OR PATIENT CABLE IN WATER, SOLVENTS, OR CLEANING SOLUTIONS (THE SENSORS AND CONNECTORS ARE NOT WATERPROOF)
- UNLESS OTHERWISE SPECIFIED, DO NOT STERILIZE SENSORS OR PATIENT CABLES BY IRRADIATION, STEAM, AUTOCLAVE OR ETHYLENE OXIDE. SEE THE CLEANING INSTRUCTIONS IN THE DIRECTIONS FOR USE FOR REUSABLE MASIMO SENSORS.
- DO NOT ATTEMPT TO REPROCESS, RECONDITION OR RECYCLE ANY MASIMO SENSORS OR PATIENT CABLES AS THESE PROCESSES MAY DAMAGE THE ELECTRICAL COMPONENTS, POTENTIALLY LEADING TO PATIENT HARM.
- ALL SENSORS AND CABLES ARE DESIGNED FOR USE WITH SPECIFIC MONITORS. VERIFY THE COMPATIBILIY OF THE MONITOR, CABLE AND SENSOR BEFORE USE, OTHERWISE PATIENT INJURY CAN RESULT.

SELECTING A MASIMO SET SENSOR

When selecting a sensor, consider, the patient's weight, the adequacy of perfusion, the available sensor sites, and the duration of monitoring. For more information refer to the following table or contact your Sales Representative. Use only Masimo SET sensors and sensor cables. Select an appropriate sensor, apply it as directed, and observe all warnings and cautions presented in the directions for use accompanying the sensor.

High ambient light sources such as surgical lights (especially those with a xenon light source), bilirubin lamps, fluorescent lights, infrared heating lamps, and direct sunlight can interfere with the performance of an SpO_2 sensor. To prevent interference from ambient light, ensure that the sensor is properly applied, and cover the sensor site with opaque material, if required. Failure to take this precaution in high ambient light conditions may result in inaccurate measurements.

SENSOR APPLICATION SITE

Unless indicated otherwise in the directions for use, reposition reusable sensors at least every 4 hours and adhesive sensors at least every 8 hours.

LNOP® REUSABLE SENSORS

(LNOP sensors must be used in conjunction with PC cables)

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNOP DCI	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP DCIP	10 - 50 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Y-I	> 1 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	N/A	N/A
LNOP TC-I	> 30 kg	± 3.5%	N/A	± 3 bpm	N/A	± 3.5%	± 3 bpm
LNOP DC-195	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP DCSC	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP TF-I	> 30 kg	± 2%	N/A	± 3 bpm	N/A	± 2%	± 3 bpm

Note: *The LNOP TF-I and TC-I sensors were not validated under motion conditions.*

LNOP® ADHESIVE SENSORS

(LNOP sensors must be used in conjunction with PC cables)

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNOP Adt	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Adtx	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Pdt	10 - 50 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Pdtx	10 - 50 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Neo	< 10 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNOP NeoPt	< 1 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNOP Neo-L	< 3 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
	> 40 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP NeoPt-L	< 1 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNOP Inf-L	3 - 20 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Neo Bridge	< 10 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNOP NeoPt Bridge	< 1 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm

LNOP® SPECIALTY SENSORS

(LNOP sensors must be used in conjunction with PC cables)

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNOP Hi-Fi Inf/Ped	3 - 10 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
	10 - 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOP Hi-Fi Neo/Adult	< 3 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm

SENSOR	Weight Range	Saturation Accuracy			Pulse Rate Accuracy	Low Perfusion Accuracy	
		60 - 80%	70 - 100%	80 - 100%		Saturation	Pulse Rate
LNOP Blue	2.5 - 30 kg	± 4%	± 3.3%	± 3%	± 3 bpm	± 3%	± 3 bpm

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNOP Trauma Adult	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm

LNOPv™ ADHESIVE SENSORS

(LNOPv sensors must be used in conjunction with PC cables)

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNOPv In	3 - 20 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOPv Ne	< 3 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNOPv Ad	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOPv Ad-L	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNOPv Pd-L	10 - 50 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm

LNCS™ REUSABLE SENSORS

(LNCS sensors must be used in conjunction with LNC cables)

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNCS DCI	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNCS DCIP	10 - 50 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNCS TC-I	> 30 kg	± 3.5%	N/A	± 3 bpm	N/A	± 3.5%	± 3 bpm
LNCS TF-I	> 30 kg	± 2%	N/A	± 3 bpm	N/A	± 2%	± 3 bpm

Note: *The LNCS TF-I and TC-I sensors were not validated under motion conditions.*

LNCS™ ADHESIVE SENSORS

(LNCS sensors must be used in conjunction with LNC cables)

SENSOR	Weight Range	Saturation Accuracy		Pulse Rate Accuracy		Low Perfusion Accuracy	
		No Motion	Motion	No Motion	Motion	Saturation	Pulse Rate
LNCS Adtx LNCS Adtx-3	> 30 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNCS Pdtx LNCS Pdtx-3	10 - 50 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNCS Inf-L LNCS Inf LNCS Inf-3	3 - 20 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 2%	± 3 bpm
LNCS Neo-L LNCS Neo	< 3 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNCS Neo-3	> 40 kg	± 2%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm
LNCS NeoPt-L LNCS NeoPt LNCS NeoPt-3	< 1 kg	± 3%	± 3%	± 3 bpm	± 5 bpm	± 3%	± 3 bpm

CLEANING AND REUSE OF MASIMO SENSORS

Reusable sensors can be cleaned per the following procedure:

1. Remove the sensor from the patient.
2. Disconnect the sensor from the monitor.
3. Wipe the entire sensor clean with a 70% isopropyl alcohol pad.
4. Allow the sensor to air dry before returning it to operation.

REATTACHMENT OF SINGLE USE ADHESIVE SENSORS

- Single use sensors may be reapplied to the same patient if the emitter and detector windows are clear and the adhesive still adheres to the skin.

NOTE: *If the sensor fails to track the pulse consistently, the sensors may be incorrectly positioned. Reposition the sensor or choose a different monitoring site.*

WARNING: TO AVOID CROSS CONTAMINATION ONLY USE MASIMO SINGLE USE SENSORS ON THE SAME PATIENT.

CAUTIONS:

- DO NOT ATTEMPT TO REPROCESS, RECONDITION OR RECYCLE ANY MASIMO SENSORS AS THESE PROCESSES MAY DAMAGE THE ELECTRICAL COMPONENTS, POTENTIALLY LEADING TO PATIENT HARM.
- DO NOT SOAK OR IMMERSE THE SENSOR IN ANY LIQUID SOLUTION. UNLESS OTHERWISE SPECIFIED, DO NOT STERILIZE ANY MASIMO SENSOR BY IRRADIATION, STEAM, OR ETHYLENE OXIDE.

Masimo SET patient cables

Reusable patient cables of various lengths are available. Only use appropriate Masimo oximetry patient cables for SpO_2 measurements. Other patient cables may cause improper Radical performance.

CLEANING AND REUSE OF MASIMO SET PATIENT CABLES

Patient cables can be cleaned per the following procedure:

1. Remove the cable from the sensor.
2. Disconnect the cable from the monitor.
3. Wipe clean with a 70% isopropyl alcohol pad.
4. Allow the cable to dry before returning it to operation.

CAUTIONS:

- CAREFULLY ROUTE PATIENT CABLES TO REDUCE THE POSSIBILITY OF PATIENT ENTANGLEMENT OR STRANGULATION.
- DO NOT SOAK OR IMMERSE PATIENT CABLES IN ANY LIQUID SOLUTION. DO NOT STERILIZE PATIENT CABLES BY IRRADIATION, STEAM, OR ETHYLENE OXIDE. SEE THE CLEANING INSTRUCTIONS IN THE DIRECTIONS FOR USE FOR REUSABLE MASIMO PATIENT CABLES.
- DO NOT ATTEMPT TO REPROCESS, RECONDITION OR RECYCLE ANY MASIMO PATIENT CABLES AS THESE PROCESSES MAY DAMAGE THE ELECTRICAL COMPONENTS, POTENTIALLY LEADING TO PATIENT HARMS.

Introduction

This section covers:

- How to test the operation of the Radical and the SatShare interface
- How to properly clean the Radical
- How to recharge and replace the batteries
- How to replace the fuses
- How to obtain service

Under normal operation, no internal adjustment or recalibration is required. Safety tests and internal adjustments should be done by qualified personnel only. Safety checks should be performed at regular intervals or in accordance with local and governmental regulations.

WARNING: ELECTRICAL SHOCK AND FLAMMABILITY HAZARD - BEFORE CLEANING THE OXIMETER, ALWAYS TURN IT OFF AND DISCONNECT THE POWER CORD FROM THE AC POWER SUPPLY.

Cleaning

To clean the display panel, use a cotton swab moistened with 70% isopropyl alcohol and gently wipe the panel.

To clean the outer surface of the oximeter, use a soft cloth dampened with a mild soap and water. Do not allow liquids to enter the interior of the instrument.

CAUTIONS:

- DO NOT AUTOCLAVE, PRESSURE STERILIZE, OR GAS STERILIZE THIS OXIMETER.
- DO NOT SOAK OR IMMERSE THE MONITOR IN ANY LIQUID.
- USE THE CLEANING SOLUTION SPARINGLY. EXCESSIVE SOLUTION CAN FLOW INTO THE MONITOR AND CAUSE DAMAGE TO INTERNAL COMPONENTS.
- DO NOT TOUCH, PRESS, OR RUB THE DISPLAY PANELS WITH ABRASIVE CLEANING COMPOUNDS, INSTRUMENTS, BRUSHES, ROUGH-SURFACE MATERIALS, OR BRING THEM INTO CONTACT WITH ANYTHING THAT COULD SCRATCH THE PANEL.
- DO NOT USE PETROLEUM-BASED OR ACETONE SOLUTIONS, OR OTHER HARSH SOLVENTS, TO CLEAN THE OXIMETER. THESE SUBSTANCES ATTACK THE DEVICE'S MATERIALS AND DEVICE FAILURE CAN RESULT.

Refer to Section 8, *Cleaning and Reuse of Masimo Sensors* for cleaning instructions of the sensor.

Battery operation and maintenance

The Radical Handheld includes a 1.5 Amp-Hour Nickel Metal Hydride battery. The Radical Docking Station may include the optional 6.5 Amp-Hour Nickel Metal Hydride battery.

Before using the Radical as a Handheld or transport monitor, the Handheld battery and the optional Docking Station battery need to be fully charged.

To charge the battery(s), attach the Handheld unit to the Docking Station. Ensure that AC power is attached to the Docking Station. Verify that the battery(s) are charging; the battery charging LED indicators on the Docking Station flash prior to charging and remain illuminated while the battery(s) are charging. A continuously flashing battery charging LED indicates that the internal battery temperature exceeds recommended operating conditions for proper battery charging. Proper battery charging will proceed when the temperature returns to recommended operating conditions.

The Handheld battery requires approximately 2 to 3 hours for charging. The optional Docking Station battery requires approximately 6 hours for charging.

When the battery charging LED indicators turn off, additional trickle charging may occur to complete charging. Although battery charging can occur while the Handheld is docked and powered on, most efficient charge times are achieved with the Handheld unit turned off.

CAUTIONS:

- ALL BATTERIES LOSE CAPACITY WITH AGE, THUS THE AMOUNT OF RUN TIME LEFT AT LOW BATTERY WILL VARY DEPENDING UPON THE AGE OF THE BATTERY.
- AT LOW BATTERY CONNECT THE RADICAL TO AC POWER TO PREVENT LOSS OF POWER.

During battery operation of the Radical, please note that the following operating conditions affect the estimated run-time of the included batteries:

- Illumination of the backlit LCD screen. To conserve battery power, keep the backlit LCD screen at minimum illumination.
- Volume of the alarm tones. To conserve battery power, keep the frequency of the audible alarms to a minimum and at minimum volume.
- The SatShare feature. To conserve battery power, always keep the unit on AC line power.

Memory effects of the battery pack may shorten run-time. When battery run time is significantly reduced, it is advisable to completely discharge and fully recharge the battery pack. To properly discharge the battery pack, use the Battery Discharge function as described in Section 4, *Service*.

CAUTION:

- IF THE RADICAL HANDHELD HAS NOT BEEN USED OR CHARGED WITHIN SEVEN (7) DAYS OR MORE, THEN RECHARGE THE BATTERY PRIOR TO USE.
- IT IS RECOMMENDED THAT THE RADICAL HANDHELD IS DOCKED TO THE DOCKING STATION ATTACHED TO AN AC POWER SOURCE WHEN IT IS NOT IN USE TO ENSURE THAT THE BATTERY REMAINS FULLY CHARGED.

The following tables outline the estimated run times of the battery powered Radical. The time estimates are based on a Radical with fully charged batteries. The time estimates are also based on a Radical with and without backlight lit, and the power save feature enabled and disabled.

The Radical is always configured to include the Handheld battery. It may optionally be configured to include the Docking Station battery. Please determine the configuration of your system before referencing the following tables.

Configuration #1:

Radical configured to only include the Handheld battery (standard configuration); the Docking Station battery is excluded.

NOTE: *For this configuration, it is advisable to operate only the Radical Handheld unit when running on battery power. Although it is possible to operate the entire Standalone unit (the Handheld attached to the Docking Station, with the Handheld battery powering the Docking Station as well) on battery power, the capacity of the Handheld battery pack is insufficient to support this mode for long periods of time. The Power Save setting in the General menu determines whether the Docking Station is powered or not during battery operation. See Section 4, General, for a detailed description on proper use of the Power Save setting.*

RADICAL CONFIGURATION	OPERATION MODE	MINIMUM RUN-TIME
HANDHELD ONLY	Power Save "yes" Backlight turned "off"	4 hrs
STANDALONE	Power Save "no" Backlight turned "on"	1 hr

Configuration #2:

Radical configured to include the Handheld and the Docking Station battery:

RADICAL CONFIGURATION	OPERATION MODE	MINIMUM RUN-TIME
STANDALONE	Power Save "yes" Backlight turned "off"	12 hrs
STANDALONE	Power Save "no" Backlight turned "on"	6 hrs

REPLACING THE BATTERIES

- Before installing or removing the battery, make sure the AC power cord is removed and power to the pulse oximeter is turned off.

To replace the Handheld battery, follow these instructions:

1. Turn the Radical Handheld off and remove the patient cable connection. Detach the Radical Handheld from the Docking Station (if docked).
2. Loosen the closure screw on the battery compartment door and lift out the battery.
3. Take a new battery, and place it in the compartment.
4. Tighten the closure screw.
5. Place Handheld into Docking Station, turn on line power and charge battery according to Section 9, *Battery Operation and Maintenance*.

CAUTION: FOLLOW LOCAL GOVERNING GUIDELINES FOR PROPER DISPOSAL OF INTERNAL BATTERIES. DO NOT INCINERATE.

WARNING: THE DOCKING STATION BATTERY SHOULD BE INSTALLED AND/OR REMOVED FROM DOCKING STATION BY QUALIFIED PERSONNEL ONLY.

REPLACING THE FUSES

Should a power problem blow one or both of the fuses in the power entry module on the rear panel, the fuse(s) will need to be replaced.

To replace the fuse(s), you will need a flat-blade screwdriver (5mm; 3/16").

To replace the fuses:

1. Disconnect unit from AC power.
2. Remove AC power code from the power entry module at the rear of the docking station.
3. Use the small flat-blade screwdriver and gently pry loose the fuse in the left portion of the power entry module, exposing the fuse holder.
4. Using the small flat-blade screwdriver, gently pry out the fuse holder.
5. Note how the fuses are placed in the fuse holder for installation of the new fuse(s).
6. To remove the fuse(s) from the fuse holder, use the edge of the screwdriver blade to pry against the bottom of the metal portion of the fuse where it is secured to the glass portion of the fuse.
7. Place the fuse(s) (1 Amp, Metric, fast acting, 5x20mm, 250V) in the fuse holder, properly orienting the fuses.
8. Slide the fuse holder back into the power entry module and press firmly to make sure it is completely seated.
9. Close the fuse cover and press gently until it seats completely, flush with the back of the docking station.
10. The unit is ready to be reconnected to AC power.

NOTE: *If the fuses blow shortly after replacement, the unit requires service.*

WARNING: FIRE HAZARD: TO PROTECT AGAINST FIRE HAZARD, REPLACE ONLY WITH FUSES OF THE SAME TYPE, CURRENT RATING, AND VOLTAGE RATING.

Performance verification

To test the performance of the Radical following repairs or during routine maintenance, follow the procedure outlined in this section. If the Radical fails any of the described tests, discontinue its use and correct the problem before returning the unit back to the user.

Before performing the following tests place the Radical Handheld into the Docking Station, connect the Radical to AC power and fully charge the Radical Handheld battery. Also disconnect any patient cables or pulse oximetry probes, as well as SatShare, serial or analog output cables from the instrument. Set the Radical to normal operating mode by selecting the Home Use parameter in the General Menu to "No".

Power-On Self-Test:

1. Connect the monitor to AC power and verify that the AC Power Indicator is lit.
2. Turn the monitor on by depressing the Power/Standby Button. Within 5 seconds all available LEDs are illuminated, a 1-second beep tone sounds, and the Masimo SET logo is displayed.
3. The blue Docking Indicator LED is illuminated and the Radical begins normal operation.

Key Press Button Test:

1. With the exception of the Power/Standby Button, press each soft key button and verify that the Radical acknowledges each key-press with an audible beep tone or by indicating a change on the display.

Alarm Limit Test:

1. With the monitor turned on, select the Menu Access key and enter the Alarm menu. Change the High Saturation Alarm parameter to a value two points below the currently selected value, and accept the change.
2. Verify that the newly set parameter is shown on the Saturation Alarm Limit Display, next to the SpO_2 or pulse rate measurement display.
3. Return the High Saturation Alarm parameter to its original setting.
4. Repeat steps 1 to 3 with the Low Saturation Alarm parameter.
5. Repeat steps 1 to 3 with the High Pulse Rate Alarm parameter.
6. Repeat steps 1 to 3 with the Low Pulse Rate Alarm parameter.
7. Reset the alarm limits again to the original settings.

Display Contrast Test:

1. With the monitor turned on, select the Menu Access key and enter the Display menu. Change the Contrast parameter by scrolling through the contrast settings.
2. Return the Contrast setting to the original value, or a value that allows maximum viewing contrast.
3. Exit the Menu system and press and hold down the Backlight/Contrast button for several seconds. The display will scroll again through all the contrast settings.
4. Release the Backlight/Contrast button again when the display shows maximum viewing contrast.

Testing with Masimo SET Tester (Optional):

1. Turn the Radical off and then on again.
2. Set the alarm limits to:

	% SpO_2	Pulse Rate
High	100	140
Low	90	50

3. Connect the Masimo SET Tester to the Patient Cable Connecter.
4. Verify that within 20 seconds a plethysmographic and a Signal IQ waveform displays. (may require the Radical to be set to the Pleth and Signal IQ display setting).
5. Verify that the SpO_2 measurement is between 79% and 84%.
6. Verify that the pulse rate measurement is between 55 bpm and 65 bpm.
7. Verify that an audible alarm occurs and that the SpO_2 measurement and the low SpO_2 alarm are flashing
8. Press the Alarm Silence button once and verify that the alarm is silenced.
9. Wait 120 seconds and verify that the alarm silence times out and the audible alarm is activated again.
10. Press the Increase Loudness button several times and verify that the loudness of the pulse beep tone increases.
11. Press the Decrease Loudness button and verify that the loudness of the pulse beep tone decreases. Press the Decrease Loudness button and verify that the loudness of the pulse beep tone can be turned off.

Nurse Call Test:

1. Disconnect the patient cable or the Masimo SET Tester from the Radical and turn the instrument on. Ensure that there are no audible alarms and that the audible alarms are not silenced. Verify the nurse call polarity is set to normal (default).
2. Connect the common lead of a digital multi-meter to the pin 12 (Nurse Call - Common) of the analog output connector on the Radical. Connect the positive lead of the multi-meter to pin 6 (Nurse Call - Normally Open) of the analog output connector and measure that the resistance is greater than 1 MΩ (open circuit).
3. Trigger an alarm on the monitor (e.g. by disconnecting a sensor after it was measuring data) and verify that the resistance is less than 35 ohms.

Analog Output Test

1. Disconnect all patient cables and sensors from the Radical. Turn the Radical off and then on again.
2. Connect the common lead of a digital voltmeter to the pin 2 (Ground) of the analog output connector on the Radical. Connect the positive lead of the voltmeter to pin 9 (Analog 1) of the analog output connector.
3. Enter the menu system and set the "Output", "Analog 1" to "0V Signal". Verify that the voltmeter measures a voltage of approximately 0V.
4. Enter the menu system and set the "Output", "Analog 1" to "1V Signal". Verify that the voltmeter measures a voltage of approximately 1.0V.
5. Repeat Steps 3 and 4, with the positive lead of the voltmeter connected to pin 15 (Analog 2).
6. Connect a patient cable and sensor and verify that the voltage on pins 9 and 15 are between 0V and 1.0V while measuring a saturation and pulse rate..

Battery Test

1. Fully charge the Radical by placing the Handheld into the Docking Station and connecting the AC power.
2. Verify that the green Handheld Battery Indicator LED is lit up.
3. When the Radical is fully charged the green Handheld Battery Indicator turns off.
4. Turn the Radical on and verify that the Battery indicator shows a full charge.

Service and repair

REPAIR POLICY

Masimo or an authorized Service Department must perform warranty repair and service. Do not use malfunctioning equipment. Have the unit repaired.

WARNING: DO NOT REMOVE THE COVER OF THE MONITOR EXCEPT FOR BATTERY REPLACEMENT. AN OPERATOR MAY ONLY PERFORM MAINTENANCE PROCEDURES SPECIFICALLY DESCRIBED IN THIS MANUAL. REFER SERVICING TO QUALIFIED SERVICE PERSONNEL TRAINED IN THE REPAIR OF THIS EQUIPMENT.

Please clean contaminated and/or dirty equipment before returning, following the cleaning procedure described in Section 9, *Cleaning*. Make sure it is fully dry before packing the equipment.

To return the Radical unit for service, please follow the Return Procedure.

RETURN PROCEDURE

Please clean contaminated/dirty equipment before returning and make sure it is fully dry before packing the equipment. Call Masimo at 800-326-4890 and ask for Technical Support. Ask for an RMA number. Package the equipment securely – in the original shipping container if possible – and enclose or include the following information and items:

- A letter describing in detail any difficulties experienced with the Pulse Oximeter. Please include the RMA number in the letter.
- Warranty information – a copy of the invoice or other applicable documentation must be included.
- Purchase order number to cover repair if the oximeter is not under warranty, or for tracking purposes if it is.
- Ship-to and bill-to information.
- Person (name, telephone/Telex/fax number, and country) to contact for any questions about the repairs.
- A certificate stating the oximeter has been decontaminated for bloodborne pathogens.

Return the Radical to the following shipping address:

For USA:

Masimo Corporation
40 Parker
Irvine, California 92618
949-297-7000

For Europe:

Masimo Europe Limited
304 RN6, Le Bois des Cotes 2
69760 Limonest
France
Tel: +33 (0) 472 17 93 70
FAX: +33 (0) 478 35 78 08

For Asia Pacific:

Masimo Japan Corporation
World Times Bldg. 4F
10-7, Ichiban-cho, Chiyoda-ku,
Tokyo 102-0082 JAPAN
Tel: 03 3237 3057
FAX: 03 3238 1110

Warranty

Masimo warrants to the initial purchaser that each new pulse oximeter will be free from defects in workmanship or materials for a period of one (1) year from the date of purchase. Masimo's sole obligation under this warranty is to repair or replace any product that Masimo deems to be covered under warranty with a repaired or a replacement pulse oximeter.

Batteries are warrantied for six (6) months.

To request a replacement under warranty, contact the licensed manufacturer or Masimo for a returned goods authorization. If the licensed manufacturer or Masimo determines that a product must be replaced under warranty, it will be replaced and the cost of shipment covered. All other shipping costs shall be the responsibility of the purchaser.

Exclusions

This warranty does not extend to any product that has been subject to misuse, neglect or accident; that has been damaged by causes external to the Product; that has been used in violation of the operating instructions supplied with the product. The warranty does not extend to any product that has been connected to an unlicensed instrument system, modified accessories or any unit that has been disassembled or reassembled by anyone but an authorized Masimo agent.

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Accessories

The following accessories and re-order parts are available with the Radical Signal Extraction pulse oximeter

PART NUMBER	ACCESSORIES
1315	REPLACEMENT BATTERY, RADICAL HANDHELD
1317	RADICAL POLE CLAMP
1395	RADICAL HANDHELD LOCK
1584	RADICAL POWER CORD LOCK, 5/PACK
1595	SATSHARE CABLE, AT01
1324	SATSHARE CABLE, DO01
1326	SATSHARE CABLE, DO02
1528	SATSHARE CABLE, DO03
1533	SATSHARE CABLE, DO04
2023	SATSHARE CABLE, DO05
1325	SATSHARE CABLE, DS01
1539	SATSHARE CABLE, DS02
1528	SATSHARE CABLE, DS03
1357	SATSHARE CABLE, HP03
1321	SATSHARE CABLE, MQ01
1789	SATSHARE CABLE, MS01
1367	SATSHARE CABLE, NK01
1368	SATSHARE CABLE, NK02
1366	SATSHARE CABLE, OH01
1646	SATSHARE CABLE, OH02
1840	SATSHARE CABLE, PM01
1323	SATSHARE CABLE, SL01
1362	SATSHARE CABLE, SL02
1322	SATSHARE CABLE, SM01
1605	SATSHARE EXTENSION CABLE
11901	RADICAL USER MANUAL - DANISH
11902	RADICAL USER MANUAL - DUTCH
11601	RADICAL USER MANUAL - ENGLISH
11715	RADICAL USER MANUAL - FRENCH
11714	RADICAL USER MANUAL - GERMAN
11716	RADICAL USER MANUAL - ITALIAN
11717	RADICAL USER MANUAL - PORTUGUESE
11718	RADICAL USER MANUAL - SPANISH
11903	RADICAL USER MANUAL - SWEDISH
12114	RADICAL SERVICE MANUAL
30475	RADICAL HANDHELD CASE
1593	MASIMO TESTER
1795	MASIMO TESTER WITH CABLE

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